

# NUCLEAR SCIENCE ABSTRACTS

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## ERRATA

NSA, Vol. 8, No. 12A, p.437. In abstract 3655, report AF-SAM-21-3501-0005-7 should be NP-5209; AF-SAM-21-3501-0005-7.

NSA, Vol. 8, No. 13, p.6. In Numerical Index of Reports, the reference for UCRL-2319(Rev) should read "2nd Revision in Rev. Sci. Instr. 25, 437-42(1954)."





# NUCLEAR SCIENCE ABSTRACTS

Vol. 8

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No. 17

## GENERAL

### ATOMIC POWER

5084  
GOAL: ECONOMIC POWER IN 10 YEARS. *Nucleonics* 12, No. 7, 48-51(1954) July.

The approaches to economic nuclear power production taken by the nine leading U.S. groups (Oak Ridge National Lab.; Westinghouse Atomic Power Div.; North American Aviation, Inc.; Argonne National Lab.; Nuclear Power Project; Foster Wheeler Corp.; Pioneer Service and Engineering Co.; Diamond Alkali Co.; Dow Chemical-Detroit Edison and Associates, Nuclear Power Group; General Electric Co.; and Monsanto Chemical Co.) are briefly described. (L.T.W.)

## BIOLOGY AND MEDICINE

5085  
Atomic Energy Project, Univ. of Calif., Los Angeles  
CENTRALLY MEDIATED EFFECTS OF CARDIAC DRUGS: STROPHANTHIN-K, QUINIDINE AND PROCAINE AMIDE. S. J. Weinberg and Thomas J. Haley. July 13, 1954. 32p. Contract AT-04-1-GEN-12. (UCLA-299)

Electrocardiograms were obtained on trained unanesthetized dogs following the injection of strophanthin-k, quinidine, and procaine amide by intravenous injection and by direct injection into the third ventricle. Data are presented indicating separate electrocardiographic changes produced by the effects of these drugs on the nervous system and on cardiac muscle. (C.H.)

5086  
Atomic Energy Project, Univ. of Rochester  
CORTISONE METABOLISM IN THE PERFUSED NORMAL AND EXPERIMENTAL CIRRHOTIC RAT LIVER. L. L. Miller and L. R. Axelrod. June 7, 1954. 27p. Contract W-7401-eng-49. (UR-328)

Normal and experimental cirrhotic rat livers were perfused with homologous heparinized blood containing approximately 15 mg % free cortisone. Blood samples were removed and analyzed by dialysis, paper chromatography, and spectrophotometry at 20, 40, 60 and 120 min as well as after 1, 3, 5, and 7 complete passes through the liver. In general the normal rat liver has a large capacity to reduce the  $\alpha$ - $\beta$  unsaturated ketone at the carbon 3 position and most of the  $\alpha$ -ketol material rapidly disappears. The cirrhotic liver loses much of its capacity for this type of reduction and dihydro forms appear in the blood along with the fully reduced metabolites. Much more of the  $\alpha$ -ketol side-chain remained after prolonged perfusion than found with the normal liver. Two metabolites were found in the cirrhotic rat liver blood which were not found in normals. (auth)

### RADIATION EFFECTS

5087  
Washington Research Labs., National Canners Association, D. C.  
INVESTIGATION OF GAMMA STERILIZATION. RESEARCH REPORT NO. 5-53. B. H. Morgan. June 1953. 46p. Contract AT(30-1)-1567. (AECU-2885)

Data are presented from studies of the effects of  $\gamma$  radiation on bacterial spores. (C.H.)

5088  
Washington Research Labs., National Canners Association, D. C.  
INVESTIGATION OF GAMMA STERILIZATION. RESEARCH REPORT NO. 7-53. B. H. Morgan. Dec. 1953. 37p. Contract AT(30-1)-1567. (AECU-2886)

Data are presented from studies of the effects of  $\gamma$  radiation on bacterial spores. (C.H.)

5089  
Atomic Energy Project, Univ. of Rochester  
QUARTERLY TECHNICAL REPORT [FOR] JANUARY 1 THRU MARCH 31, 1954. May 10, 1954. 35p. Contract W-7401-eng-49. (UR-330)

Preliminary tests of silicate fiber dust filters have shown that their collection efficiency is above 99.6%. A convenient, portable unit for the production of radiant energy burns is described, using as the source of radiation, a 2000 watt tungsten lamp. Means are provided for the control of radiant power output of the unit, and of exposure time. Maximum output is about 9.4 cal/cm<sup>2</sup>/sec, with a 95% tolerance interval of about 3%. The Beckman IR-2 infrared spectrophotometer was converted to handle micro samples by the installation of a beam condensing system. The compartment holding the lens systems may be inserted in the instrument without impairing any of the usual functions. (For preceding period see UR-311.) (C.H.)

5090  
CHANGES IN SOME GASTROINTESTINAL FUNCTIONS FOLLOWING X-IRRADIATION. Paul F. Fenton and Harrison M. Dickson (Brown Univ., Providence, Rhode Island). *Am. J. Physiol.* 177, 528-30(1954) June.

Gastric emptying and food intake in mice have been found to be reduced for a period of less than 24 hours after irradiation with a dose of 500 r. The inhibitory effect of hypertonic solutions on gastric evacuation was abolished by irradiation. Fecal output of total solids and of nitrogen was reduced for 48 hours after irradiation. The concentration of Cr<sub>2</sub>O<sub>3</sub> marker in the feces was reduced for a 2-day period. Irradiation had no effect on pancreatic and intestinal amylase content under the conditions employed in these experiments. The amylase content of the pancreas was found to decrease with age. (auth)

5091  
INDUCED CHROMOSOME MUTATIONS IN DROSOPHILA MELANOGASTER BY FAST ELECTRONS AND X RADIATION. G. Höhne and G. Schubert (Universität Frauenklinik Hamburg-Eppendorf, Germany). *Strahlentherapie* 94, 72-8(1954). (In German)

*Drosophila melanogaster* was exposed to a 3-Mev



electron beam from a betatron and to 200-kv x radiation, such as is generally used in therapy, for the purpose of studying the effect of these radiations on chromosome mutations. With respect to the reciprocal translocations between the 2nd and the 3rd chromosome that were covered by the analysis of the crossing over, it was found that the increase in the rate of mutation induced by the radiation was a little greater than proportional to the dose. No differences were found between the effects produced by these two radiations of unlike differential ionization. (auth)

5092

ON THE INFLUENCE OF SMALL REPEATED RADIATION DOSES ON THE FERTILITY AND LITTER SIZE OF THE WHITE MOUSE. H. Langendorff and M. Langendorff. (Universität Freiburg, Germany). *Strahlentherapie* 94, 119-25(1954). (In German)

If male mice are daily irradiated with 2.5 r and then paired with normal female animals, the fertility decreases more rapidly than the controls. This decrease of fertility is, however, preceded by an initial fluctuation which often results in a minor temporary increase of the fertility of the animals. The number of young is not influenced by the action of the radiation. The reasons for this behavior of the fertility rate after the irradiation is mainly seen in an impairment of certain constitutional factors. In view of the unchanged number of young in the litter, genetic factors scarcely seem to be involved. (auth)

5093

MALFORMATIONS OF THE ADULT CLAW FROG (XENOPUS LAEVIS DAUD.) AFTER X RADIATION IN THE EMBRYONIC STAGES. Hans R. Schinz and Hedi Fritz-Niggli. *Strahlentherapie* 94, 147-51(1954). (In German)

It is shown that irradiations of *Xenopus laevis* in the early embryonic stages do not prevent some of the animals from developing into full-fledged toads. The majority of the toads are normal. The following malformations were observed: one unilateral microphthalmia; edemas coupled with chondrodystrophy and polydactylia. The malformations seem to be due to certain disturbances of the corresponding blastemas which, at the time of the irradiation, happened to be in a sensitive stage. (auth)

5094

DIFFERENTIATION AND THE REACTION OF RAT EMBRYOS TO RADIATION. James G. Wilson (Univ. of Cincinnati, Ohio). *J. Cellular Comp. Physiol.* 43, Supplement 1, 11-37(1954) May.

Rat embryos on the eighth, ninth, tenth, or eleventh day of gestation were exposed to doses of 12.5 to 600 r directly through an abdominal incision in the mother. Lead plates were arranged so that selected embryos could be irradiated while the mother and remaining embryos were shielded. The irradiated and nonirradiated embryos were removed one to several days later, or at term, and compared as to weight, the presence of malformations, and the rate of intrauterine mortality. Results are summarized. (auth)

5095

THE EFFECT OF IONIZING RADIATIONS ON AMPHIBIAN DEVELOPMENT. Roberts Rugh (Columbia Univ., New York). *J. Cellular Comp. Physiol.* 43, Supplement 1, 39-75(1954) May.

Studies on effects of radiation on amphibia undergoing metamorphosis are reviewed, and data are presented from studies of the radiosensitivity of each developmental stage, the most frequent types of abnormality following irradiation of embryos, and modifications produced in radiation injury by cysteamine. (C. H.)

5096

RADIOTRACER TECHNIQUES IN EMBRYOLOGICAL RESEARCH. James Norman Dent and Ernest L. Hunt (Univ.

of Virginia, Charlottesville). *J. Cellular Comp. Physiol.* 43, Supplement 1, 77-101(1954) May.

Applications of radiotracer techniques to developmental physiology are reviewed. (C. H.)

5097

A STUDY OF THE OUTCOME OF PREGNANCY IN WOMEN EXPOSED TO THE ATOMIC BOMB BLAST IN NAGASAKI. James N. Yamazaki, Stanley W. Wright, and Phyllis M. Wright (Atomic Bomb Casualty Commission, Nagasaki, Japan). *J. Cellular Comp. Physiol.* 43, Supplement 1, 319-28(1954) May.

A study has been made of the outcome of pregnancy in women who were pregnant at the time of the atomic bomb explosion in Nagasaki. Among 30 mothers with one or more major signs of radiation, there were 7 fetal deaths (23.4%), 6 neonatal and infant deaths (26%), and 4 instances of mental retardation among 16 surviving children (25%). The over-all morbidity and mortality is approximately 60% in this group of mothers. This is in sharp contrast to the group of mothers without major signs, but within 2000 meters where the over-all mortality was only 10%, and in the control group where it was about 6%. The mean height and head circumference of children born to mothers with major signs was significantly smaller than in those children born to mothers in the control group. It is difficult to evaluate the effect of radiation on this mortality and morbidity since other factors such as trauma, burns, infection, etc., may have a deleterious effect on the fetus. The evidence strongly suggests, however, that radiation either directly to the fetus, or indirectly as a result of its effect on the maternal tissues, was of considerable importance in determining the outcome of these pregnancies. (auth)

5098

PROBABLE SIDE-EFFECT OF NUCLEAR REACTIONS IN THE BIOLOGICAL ACTION OF FAST PROTONS. Lars Ehrenberg (Univ. of Stockholm, Sweden) and Göran Andersson (Univ. of Uppsala, Sweden). *Nature* 173, 1086(1954) June 5.

Dry dormant seeds of Bonus barley were irradiated with 160-Mev protons in the scattered beam of the Uppsala synchrocyclotron. From the specific ionization of the high-energy protons, their efficiency in producing given biological effects was expected to be between those of  $\gamma$  and x rays. However, certain qualitative effects were found to be intermediate between those of sparsely ionizing ( $x$  and  $\gamma$  rays) and densely ionizing radiations (pile neutrons and  $\alpha$  particles). An examination of possible explanations led to the conclusion that the unexpected effects must be ascribed to secondary ionization caused by short-range particles (mostly  $\alpha$  particles and low-energy protons) formed in inelastic collisions of the high-energy protons with the nuclei of the seed material. (A. G. W.)

5099

CELLULAR DESTRUCTION AND PROTEIN BREAKDOWN INDUCED BY EXPOSURE TO X-RAYS. I. Kurt Schreier, Nicola DiFerrante, George W. Gaffney, Louis H. Hempelmann, and Kurt I. Altman (Univ. of Rochester, School of Medicine and Dentistry, N. Y.). *Arch. Biochem. and Biophys.* 50, 417-20(1954) June.

The breakdown of  $C^{14}$ -labeled tissue proteins was investigated. The data suggest that radiation causes an expansion in the first glycine pool as evidenced by the increased corrected dilution coefficient during the 6 to 24 hr and 0 to 18 hr collection periods. The level of hippuric acid excretion remains unchanged after exposure to ionizing radiation. (auth)

5100

EFFECT OF TOTAL BODY IRRADIATION ON RABBIT PITUITARY AS MEASURED BY GONADOTROPIN RESPONSE IN CHICKS. John J. Lane, John R. Paysinger, R. L. Murphree, John H. Rust, and Bernard F. Trum



(Univ. of Tennessee Atomic Energy Commission Agricultural Research Program, Oak Ridge). Proc. Soc. Exptl. Biol. Med. **86**, 36-8(1954) May.

Rabbit pituitaries from animals exposed to 750 and 1100 r of total body  $\text{Co}^{60}$  gamma irradiation showed an early suppression of gonadotropin principles as measured by the chick gonad response. The 750 r group showed the depression on the 8th day after irradiation while in the 1100 r group the suppression was evident by day one and was sustained through day 7. After this time the gonadotropin activity in both groups returned to the normal level. (auth)

5101  
USE OF TISSUE CULTURE MEDIUMS STERILIZED WITH GAMMA RADIATION FROM COBALT-60. Donald J. Merchant, Richard D. Stewart, Lloyd L. Kempe, and John T. Graikoski. Proc. Soc. Exptl. Biol. Med. **86**, 128-31 (1954) May.

Plasma, serum, and embryonic extract contaminated with gram negative and non-sporeforming gram positive bacteria have been shown to be sterilized by a dosage of  $2 \times 10^5$  rep of gamma radiation from  $\text{Co}^{60}$ . Such treatment failed to alter the properties of these materials as related to their use in tissue culture work. These studies are being extended to cover dosages necessary to kill bacterial spores and efforts are being made to put the work on a more quantitative basis by utilizing established strains of tissue culture cells for assay procedures. (auth)

5102  
IRRADIATION OF THE PITUITARY OF THE RAT WITH HIGH ENERGY DEUTERONS. C. A. Tobias, D. C. Van Dyke, M. E. Simpson, H. O. Anger, R. L. Huff, and A. A. Koneff (Univ. of California, Berkeley). Am. J. Roentgenol. Radium Therapy Nuclear Med. **72**, 1-21(1954) July.

The use of deuterons for alteration or destruction of a localized volume of tissue deep within the body has been demonstrated by irradiation of the pituitary of the rat employing doses of from 3,150 to 25,200 rep. It has been shown that the degree of destruction observed following irradiation of the pituitary is a function of time as well as dose. (auth)

5103  
MODIFICATION OF ERYTHROPHAGOCYTOSIS IN VITRO AFTER SINGLE TOTAL IRRADIATION OF NORMAL AND SPLENECTOMIZED RATS. Jean-François Duplan, Gérard de Brion, and Odette Lartigue. Compt. rend. **238**, 2567-9(1954) June 28. (In French).

Radioinduced modifications in erythrophagocytosis in the spleen are demonstrated by comparing data on the erythrophagocytotic index of normal, splenectomized, normal-irradiated, and splenectomized-irradiated rats. (C.H.)

## RADIATION HAZARDS AND PROTECTION

5104  
Livermore Research Lab., Calif. Research and Development Co.

EMERGENCY CREW TRAINING AND MEDICAL DECONTAMINATION FACILITY AT THE LIVERMORE RESEARCH LABORATORY. G. A. Blanc, W. A. Clark, and G. T. Saunders. June 1954. 17p. Contract AT(11-1)-74. (LRL-142)

The formation, training, and operation of the emergency crew, (disaster squad), of the Livermore Research Laboratory are described. In addition, the medical decontamination facilities, designed to adequately provide emergency care in the case of radiocontaminated injuries, are described. (auth)

5105  
Sanitary Engineering Center, Public Health Service  
RADIOLOGICAL HEALTH HANDBOOK. Simon Kinsman,

comp. and ed. Apr. 1954. 340p. (NP-5239)

This edition of the handbook contains a large amount of readily available information of interest to anyone working in the field of radiation. Sections are included on physical, chemical, and mathematical data; radioassay and decay data; radiation protection data; a table of isotopes which includes decay schemes; and a glossary. (C.H.)

5106  
SEX HORMONES AS PROTECTIVE AGENTS AGAINST RADIATION MORTALITY IN MICE. E. A. Mirand, J. G. Hoffman, M. C. Reinhard, and H. L. Goltz (Roswell Park Memorial Inst., Buffalo, N. Y.). Proc. Soc. Exptl. Biol. Med. **86**, 24-7(1954) May.

Diethylstilbestrol and estradiol benzoate reduce the acute radiation mortality in mice. The androgens, testosterone propionate and dehydroepiandrosterone cyclopentylpropionate, afford no protection against acute lethal radiation dose. The estrogens afford protection when given for 7 days before or after the irradiation. No toxic effects due to estrogens or androgens were seen in the administration of the hormones for 7 days after irradiation. (auth)

5107  
PROTECTIVE EFFECT OF HYPOXIA AGAINST IRRADIATION INJURY OF THE RAT BONE MARROW AND SPLEEN. W. A. Rambach, H. L. Alt, and John A. D. Cooper. (Northwestern Univ. Medical School, Chicago). Proc. Soc. Exptl. Biol. Med. **86**, 159-61(1954) May.

Rats irradiated in a hypoxic atmosphere show a slightly higher cellularity and much greater rate of DNA synthesis in the bone marrow and spleen after 96 hours than rats irradiated at ground level. Thirty hours of intermittent hypoxia preceding irradiation at low oxygen tensions does not give additional protection. A striking parallelism exists in the cellular reactions in the bone marrow and spleen following irradiation, both at normal atmospheric pressures and at low oxygen pressure. Irradiation of animals at low oxygen pressures appears to reduce the biological effectiveness of 800 r on the bone marrow to 600 r. (auth)

5108  
EFFECTS OF PANTOTHENIC ACID AND ITS ANALOGS IN RADIATION INJURY BY  $\text{P}^{32}$ . Camillo Artom (Bowman Gray School of Medicine, Wake Forest College, Winston-Salem, N. C.). Proc. Soc. Exptl. Biol. Med. **86**, 162-5 (1954) May.

A significant protection against the injurious effects of  $\text{P}^{32}$  was observed by the administration of pantothenic acid to mice on a deficient diet. Pantoyltaurine was almost as effective in this respect as the natural vitamin.  $\omega$ -methyl pantothenate was totally ineffective. (auth)

5109  
STUDY OF THE RADIOACTIVITY OF THE ATMOSPHERE OF A LABORATORY BY NUCLEAR EMULSIONS. Enis Erdik (Institut de Physique atomique, Lyon, France). J. phys. radium **15**, 445-51(1954) June. (In French)

The  $\alpha$ -emitting elements which are present in the atmosphere of a hot laboratory were determined by a measurement of the track lengths in a nuclear emulsion. The radioactivity of the laboratory was compared with that of free air. (tr-auth)

## RADIOGRAPHY

5110  
Army Medical Research Lab., Fort Knox  
RAPID MILITARY AND DISASTER RADIOGRAPHY. Arthur Carpenter and Omer Smith. Feb. 5, 1954. 19p. (AMRL-136)

A rapid and inexpensive x-ray processing technique using radiographic paper instead of film reduces processing time



to less than one minute and can be carried out in the field independent of local power and water supplies. (auth)

5111

MICROTOPOLOGIC COORDINATION OF HISTOLOGICAL  $\alpha$  RAY RADIOAUTOGRAPHS BY MEANS OF A PHOTOCOPY OF THE TISSUE STRUCTURE. Hermann Schaefer (Max-Planck Institut für Biophysik, Frankfurt (Main), Germany). Strahlentherapie 94, 140-6(1954). (In German)

# RADIOTHERAPY

5112

RADIOACTIVE IODINE IN MALIGNANT MELANOMA. Ross C. Kory, Robert G. Tucker, and George R. Meneely (Vanderbilt Univ. School of Medicine, Nashville, Tennessee). Am. J. Roentgenol. Radium Therapy Nuclear Med. 72, 124-32(1954) July.

Inorganic radioactive iodine administered orally in tracer quantities was not concentrated by malignant melanoma tissue in nine patients with this disease. Therapeutic trial with doses of 50 to 65 mc of radioactive iodine proved totally ineffective in eight patients with metastatic malignant melanoma. No discernible alteration in the course of the disease could be demonstrated in any of these patients. (auth)

5113

TISSUE DISTRIBUTION OF BORON COMPOUNDS IN RELATION TO NEUTRON CAPTURE THERAPY OF CANCER. Herbert B. Locksley and William H. Sweet. Proc. Soc. Exptl. Biol. Med. 86, 56-63(1954) May.

Recent application of the atomic pile to the neutron-capture therapy of human brain tumors has focussed attention on the biological behavior of boron compounds. Studies reported in mice and man indicate that borax and boric acid are rapidly absorbed and distributed throughout the body. Uptake by the various organs and tumor describes a family of similar curves such that the faster the rise in concentration, the higher and earlier is the peak. All tissues studied, except brain, reach a peak by 30 minutes. Borate is rapidly excreted by the kidneys as a "low-threshold substance" in a class with urea and sulfate, and clearance from the blood in mice proceeds with an exponential half time of approximately 65 minutes. Concentrations of borate in the tissues of normal mice are directly proportional to dosage for at least 2 hours after injection over a range of 18 to 700  $\mu\text{g/g}$  body weight. At equilibrium distribution, studied in nephrectomized mice, borate is uniformly distributed throughout the body water, with a 10 to 20% excess bound in the intracellular compartment. This excess is bound more tenaciously in brain than in other tissues and appears to be responsible for the toxicity of these compounds. Study of the factors determining the concentration ratio between neoplasm and surrounding normal tissues indicates that boron-neutron treatment offers little promise for malignant tumors other than those of the brain. (auth)

# TOXICOLOGY STUDIES

5114

INVESTIGATIONS ON THE PROBLEM OF RADIUM POISONING. VII. THE EXCRETION OF RADIOACTIVE SUBSTANCES FROM THE ANIMAL BODY DURING THE FIRST WEEK AFTER INOCULATION. (EXPERIMENTAL RESULTS OF STUDIES ON DOGS.). Hermann Muth (Max-Planck Institut für Biophysik, Frankfurt (Main), Germany). Strahlentherapie 94, 126-36(1954). (In German)

Blood level and excretion determinations were made following oral and intravenous administration of Ra to dogs. Applications of the results to the diagnosis of Ra poisoning by the determination of urinary and fecal Ra excretion are discussed. (J.S.R.)

5115

EFFECTS OF RADIOMIMETIC SUBSTANCES ON EMBRYONIC DEVELOPMENT, WITH SPECIAL REFERENCE TO NITROGEN MUSTARDS. Dietrich Bodenstein (Army Chemical Center, Maryland). J. Cellular Comp. Physiol. 43, Supplement 1, 179-205(1954) May.

Studies of the effects of nitrogen mustard and of sex hormones on amphibian embryonic development are reviewed, and the radiomimetic effects of these substances are discussed. (C. H.)

5116

INFLUENCE OF X-IRRADIATION ON OXYGEN POISONING IN MICE. Rebeca Gerschman, Daniel L. Gilbert, Sylvanus W. Nye, and Wallace O. Fenn (Univ. of Rochester School of Medicine and Dentistry, Rochester, N. Y.). Proc. Soc. Exptl. Biol. Med. 86, 27-9(1954) May.

The survival time of mice in 6 atmospheres of oxygen was about 40 minutes. The average survival times were prolonged 12, 22, 34, and 146 minutes, respectively, when the mice were irradiated (8800 r) 30, 48, 72 and 84 hours previously. Anorexia may have contributed to the observed protection. (auth)

# TRACER APPLICATIONS

5117

Atomic Energy Project, Univ. of Calif., Los Angeles PLANT UPTAKE OF  $\text{Sr}^{90}$ ,  $\text{Ru}^{106}$ ,  $\text{Cs}^{137}$ , AND  $\text{Ce}^{144}$  FROM THREE DIFFERENT TYPES OF SOILS. Evan M. Romney, William A. Rhoads, and Kermit Larson. June 10, 1954. 28p. Contract AT-04-1-GEN-12. (UCLA-294)

5118

Radiation Lab., Univ. of Calif., Berkeley A SURVEY OF THE RATES AND PRODUCTS OF SHORT-TERM PHOTOSYNTHESIS IN PLANTS OF 9 PHYLA. Louisa Norris, R. E. Norris, and M. Calvin. May 1954. 22p. Contract W-7405-eng-48. (UCRL-2563)

Short-term photosynthetic experiments using  $\text{C}^{14}\text{O}_2$  and paper chromatography were performed with 27 different plants representing nine phyla. There is a remarkable uniformity in the types of ethanol-soluble compounds which became radioactive in the entire group of plants used. The amounts of the different compounds varied considerably percentage-wise among the various plants as would be expected because of their inherent metabolic differences and the variations in their physiological states induced by experimental conditions. Sucrose became radioactive in very different amounts in two major groupings of plants: those containing only photosynthetic tissue and those containing non-photosynthetic tissue as well. The amount of radioactive sucrose in the former group was much lower than that in the latter. An unidentified compound became radioactive in appreciable amounts in two blue-green algae, but was radioactive in very small amounts or not visible at all on the chromatograms of all other plants. (auth)

5119

Radiation Lab., Univ. of Calif., Berkeley PHOTOSYNTHESIS: FIRST REACTIONS. A. A. Benson. May 20, 1954. 14p. Contract W-7405-eng-48. (UCRL-2568)

The role of photochemically produced reduction in photosynthesis is discussed, and data are presented from studies of  $\text{C}^{14}\text{O}_2$  fixation during carbohydrate synthesis which support the theory advanced for the mechanism of the first steps of carbohydrate synthesis. (C.H.)

5120

BIOCHEMICAL CONSIDERATION OF DISTRIBUTION. Granvil C. Kyker (Oak Ridge Inst. of Nuclear Studies, Tenn.). Am. J. Med. Sci. 227, 572-89(1954) May.

There are several well established factors known to influence prominently the metabolic pattern of distri-



bution of internally administered radioisotopes. The potential value of most isotopes for internal use in therapy remains largely obscure. New ones will undoubtedly arouse interest and offer apparent advantages. Besides the many factors profoundly affecting their distribution, removal of internally administered radioisotopes is in general an unsolved problem. Extensive information and experience from the study of a radioisotope in animals prior to its medical use are therefore emphasized as measures of extreme importance. (auth)

5121

EFFECT OF AMINOPTERIN ON RADIOACTIVITY OF RAT LIVER- AND INTESTINAL-RIBONUCLEIC ACID AFTER  $C^{14}$  FORMATE INJECTION. John L. Martin and John R. Totter (Univ. of Arkansas, Little Rock). *Proc. Soc. Exptl. Biol. Med.* **86**, 41-2(1954) May.

Treatment of albino rats four times with 100  $\mu$ g of aminopterin during a 68-hour period resulted in a severely lowered white blood cell count. The treated animals showed a reduced uptake of  $C^{14}$  formate in intestinal ribonucleic acid while their liver ribonucleic acid showed a markedly increased specific activity as compared with controls. (auth)

5122

A SIMPLIFIED METHOD FOR DETERMINATION OF LIPIDE- $C^{14}$  IN LIVER. Hans Baruch and I. L. Chaikoff (Univ. of California School of Medicine, Berkeley). *Proc. Soc. Exptl. Biol. Med.* **86**, 97-9(1954) May.

A rapid method for determination of lipide- $C^{14}$  in experiments in which liver slices are incubated with  $C^{14}$ -labeled compounds is described. Data on the reliability of the procedure, and a comparison of values obtained by this simplified procedure with those obtained by the previous laborious methods are presented. (auth)

## WASTE DISPOSAL

5123

Livermore Research Lab., Calif. Research and Development Co.

WASTE DISPOSAL—DECONTAMINATION AND DECONTAMINATION LAUNDRY FACILITIES. W. A. Clark. May 1954. 25p. Contract AT(11-1)-74. (LRL-120)

This report describes the waste disposal, decontamination, and decontamination laundry facilities at the Livermore Research Laboratory. Photographs of the facilities and some of the procedures are included. (auth)

## CHEMISTRY

5124

Ames Lab.

TRANSPORT NUMBERS IN PURE FUSED SALTS. Frederick R. Duke and Richard Laity. [June 25, 1954]. 3p. Contract [W-7405-eng-82]. (ISC-496)

The first practical method for measuring the transport numbers of the ions in pure fused salts has been devised. By means of a cell which is simple to construct and operate the transport numbers for molten lead chloride were determined. A Hittorf-type cell cannot be used for pure salts, since electrolysis causes a change in quantity, rather than concentration, of electrolyte in each compartment. This accumulation of salt is not observed, since it is free to flow back to the depleted compartment unless a restraining membrane is inserted (S. Karpacher and S. Paiguer, *Zhur. Fiz. Khim.* **23**, 942(1949)). This membrane must allow the ready passage of the ions carrying the current and, at the

same time, resist the flow of the bulk of the liquid. By offering the liquid a much more accessible path by which to equalize the hydrostatic pressure difference which develops, a ready means of measuring the accumulated salt is afforded. The cell is constructed of pyrex and consists of two vertical compartments connected through two horizontal tubes, one above the other. The upper of these is a piece of 2.5-mm capillary tubing. The lower contains the membrane which is to separate the compartments. For this purpose fritted glass disks of "ultrafine" porosity are the most suitable. The compartments themselves are large tubes near the bottom which taper rapidly up to the level of the capillary. Above this point each side consists of uniform tubing of 6-mm inside diameter flared sharply at the top to permit easy introduction of material. Through the bottom of each compartment is sealed a piece of tungsten wire. In operation the electrodes consist of pools of molten lead which cover the tungsten wires. Above this the cell is filled with molten lead chloride in such a way that an air bubble is trapped in the capillary. The difference in levels which develops on electrolysis is most readily equalized by flow through the capillary, so that the displacement of the bubble provides an accurate measure of the volume changes occurring. The cell is most conveniently used as a null instrument by adding a weighed quantity of powdered  $PbCl_2$  to one compartment and measuring the number of coulombs required to return the bubble to its original position. Assuming the only current carrying species to be  $Pb^{++}$  and  $Cl^-$ , it can readily be shown that the transport number of the negative ion is given by the equation

$$t = \frac{\pm \left( \frac{96,500 \text{ wt salt}}{\text{coulombs passed}} \right) + \left( 2 \text{ eq wt metal} \times \frac{\text{Density of salt}}{\text{Density of metal}} \right)}{2 \text{ eq wt salt}}$$

the positive sign being used in this case since the bubble moves toward the cathode during electrolysis. Using the data of Lorenz et al., (*Z. physik. Chem.* **61**, 468(1907)) and that of Pascal and Jouniaux (*Compt. rend.* **158**, 414-16(1914)) for the densities of lead chloride and lead, the value of  $t$  at 565°C is found to be  $0.758 \pm 0.014$  (average deviation for 20 experiments). Substantially the same result was obtained using a plug of tightly packed asbestos as a membrane, but "fine" and "medium" porosity fritted disks permitted enough backflow to introduce appreciable errors. (Entire report.)

5125

Los Alamos Scientific Lab.

HYDROGEN RECOMBINER—CONVECTION MODEL. Harold M. Busey. Mar. 1954. 15p. Contract W-7405-eng-36. (LA-1647)

In this full-scale recombiner unit, catalyst pellets were found to be superior to heated wires. Quite, automatic, reliable operation can be expected when there is available one catalyst pellet per ml of  $H_2$  expected per minute. It is advisable to have an excess of catalyst present, to heat it before a cold start-up of a reactor, and to have no screens present. Some precaution, such as use of baffles, should be taken to prevent the catalyst from becoming coated with solids from a spray. Also, the temperature of the catalyst should be observed so that if it fails to heat or if the temperature exceeds 400°C the hydrogen flow can be stopped. (auth)

5126

Radiation Lab., Univ. of Calif., Berkeley

THE DEGRADATION OF COLCHICINE TO OCTAHYDRO-DEMETHOXYDESOXYDESACETAMIDOCOLCHICINE.

Henry Rapoport, Arthur R. Williams, John E. Campion, and Donald E. Pack. Mar. 1954. 22p. Contract W-7405-eng-48. (UCRL-2514)



Although a complex mixture of difficultly separable products is formed on hydrogenation of colchicine, replacement of the methoxyl of ring C by dimethylamino and hydrogenation of the thus formed N,N-dimethylamino-colchicide results in a good yield of easily purified tetra-hydrodemethoxycolchicine. By conversion to the mercaptole and desulfurization, the carbonyl group is transformed to methylene giving hexahydrodemethoxydesoxycolchicine. Removal of the acetamido group is accomplished by heating with phosphorus pentoxide in xylene and hydrogenation yields octahydrodemethoxydesoxydesacetamidocolchicine. This degradative sequence very reasonably takes place without rearrangement in the colchicine carbon skeleton and thus affords a degradation product whose synthesis would establish the nature of ring C. (auth)

5127

COMPLEX IONS. IV. THE ACIDITY AND ALKALINE EARTH COMPLEXES OF ANILINE-DIACETIC ACID AND ITS SUBSTITUTION PRODUCTS. (Komplexone. IV. Die Acidität Und Die Erdalkalikomplexe Der Anilino-Diessigsäure Und Ihrer Substitutionsprodukte). G. Schwarzenbach, A. Willi, and R. O. Bach. Translated from *Helv. Chim. Acta* **30**, 1314-19(1947). 10p. (AEC-tr-1935)

5128

COMPLEX IONS. V. ETHYLENEDIAMINETETRA-ACETIC ACID. (Komplexone. V. Die Äthylendiamin-Tetraessigsäure). G. Schwarzenbach and H. Ackermann. Translated from *Helv. Chim. Acta* **30**, 1798-1804(1947). 8p. (AEC-tr-1936)

5129

THE COMBUSTION OF GASEOUS HYDRAZINE. Peter Gray and J. C. Lee (Dept. of Chemical Engineering, Tennis Court Road, Cambridge, England). *Trans. Faraday Soc.* **50**, 719-28(1954) July.

The explosive combustion of gaseous hydrazine has been examined. The total pressures required for explosion of mixtures of hydrazine with oxygen have been measured from 370 to 540°C. In the explosion of stoichiometric mixtures, oxidation is complete:  $N_2H_4(g) + O_2(g) = N_2(g) + 2H_2O(g)$ ,  $\Delta H = -138,000$  cal/mole. Explosion occurs somewhat more readily in oxygen-rich mixtures and is hindered by a surface coating of KCl. This indicates that the reaction is not a simple bimolecular transformation; free radicals are probably involved. Explosion is made more difficult by an increase in surface/volume ratio and by the addition of helium; added argon and nitrogen facilitate explosion. Comparison of the thermal properties of these mixtures containing inert diluents suggests that explosion is due to self-heating. No evidence has been found that the heterogeneous decomposition interferes with the explosive combustion. A new mode of reaction has been observed. At temperatures above 420°C and at pressures too low for explosive combustion, a feeble, delayed ignition occurs after a long induction period. For this process, both lower and upper pressure limits exist. The hydrogen + oxygen reaction is thought to be responsible for this delayed ignition. At higher temperatures (600 to 700°C) the explosive decomposition of pure hydrazine has been observed. (auth)

5130

VISCOSITY OF NITRIC OXIDE-NITROGEN DIOXIDE SYSTEM IN LIQUID PHASE. H. H. Reamer, G. N. Richter, and B. H. Sage (California Inst. of Tech., Pasadena). *Ind. Eng. Chem.* **46**, 1471-4(1954) July.

Viscosity of the liquid phase was measured for NO-NO<sub>2</sub> mixtures in the temperature interval between 40 and 280°F for pressures up to 5000 psi. Data were obtained upon three mixtures within the composition interval between 0 and 0.3 weight fractions nitric oxide. The measurements were made with a rolling ball viscometer. The results

indicate that the viscosity of the liquid phase is not influenced to a large extent by changes in pressure or composition within the range of conditions investigated. The effect of pressure and temperature upon the viscosity of the liquid phase of these mixtures is in reasonable agreement with available data for the viscosity of pure nitrogen dioxide. (auth)

5131

WET COMBUSTION, AN ALTERNATIVE TO ELUTION WHEN ANALYSING ION EXCHANGE RESINS. Erik Högföldt and Peder Kierkegaard (Royal Inst. of Tech., Stockholm, Sweden). *Acta Chem. Scand.* **8**, No. 4, 585-90(1954).

It is shown that it is possible to destroy the organic constituents of an ion exchange resin by wet combustion using a mixture of conc. nitric and perchloric acids. At the end of the reaction a clear solution is usually obtained. This fact makes it possible to use wet combustion as an alternative to elution when analyzing small amounts of ion exchange resins for metals. Resins of the phenol formaldehyde type are more easily dissolved than resins of the polystyrene type and are to be preferred. Material balance studies show that wet combustion does not affect the accuracy of the analyses in the cases studied. A number of applications are suggested, and it is stressed that, when analyzing for ions, which can only be eluted with difficulty, wet combustion is an attractive method compared to elution. (auth)

5132

ON THE EXISTENCE OF A METALLIC MOLYBDENUM OXIDE. Nils Schönberg (Univ. of Uppsala, Sweden). *Acta Chem. Scand.* **8**, No. 4, 617-19(1954).

A metallic molybdenum oxide with the probable ideal formula Mo<sub>3</sub>O has been prepared by the reaction between Mo powder and MoO<sub>3</sub> at a comparatively low temperature. The structure of the oxide is related to that of the Cr<sub>3</sub>O and W<sub>3</sub>O phases of the "ordered" and "disordered" A 15 type, respectively. Nine Mo atoms are distributed at random over the positions 4 (a) 0,0,0 + 8 (c)  $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$  in the space-group O<sub>h</sub><sup>3</sup>-Fm3m, and the O atoms are most likely located in the position 4 (b)  $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$  implying a crystal lattice of a defective BiF<sub>3</sub> type. The magnitude of the Mo—O distances seems to indicate a fairly large ionization of the O atoms. (auth)

5133

LOW-TEMPERATURE HEAT CAPACITIES AND ENTROPIES AT 298.16°K. OF MANGANESE SESQUIOXIDE AND NIOBIUM PENTOXIDE. E. G. King (Bureau of Mines, Berkeley, Calif.). *J. Am. Chem. Soc.* **76**, 3289-91(1954) June 20.

Low temperature heat capacity measurements of manganese sesquioxide (Mn<sub>2</sub>O<sub>3</sub>) and niobium pentoxide (Nb<sub>2</sub>O<sub>5</sub>) were conducted throughout the temperature range 51 to 298°K. The heat capacity of manganese sesquioxide shows a pronounced maximum at 79.4°K. The entropies at 298.16°K are 26.4 ± 0.5 cal/deg mole for manganese sesquioxide and 32.8 ± 0.2 cal/deg mole for niobium pentoxide. (auth)

5134

POLAROGRAPHIC STUDIES OF RUTHENIUM IN OXIDATION STATES IV, VI, VII, AND VIII. Meyer D. Silverman and Henri A. Levy (Oak Ridge National Lab., Tenn. and Univ. of Tennessee, Knoxville). *J. Am. Chem. Soc.* **76**, 3319-21(1954) June 20.

Standard potentials of -0.59 and -1.00 volt have been obtained polarographically for the ruthenate-perruthenate and perruthenate-ruthenium tetroxide couples, respectively, using a stationary platinum electrode. (auth)

5135

DIFFUSION ACROSS AN INTERFACE. P. L. Auer and E. W. Murbach (California Research and Development Co.,



Livermore). *J. Chem. Phys.* **22**, 1054-9(1954) June.

Ideal diffusion in the sense of Fick's law in a heterogeneous system composed of two liquids is discussed by means of a three-region model where the two bulk liquid regions adjoin a third region which characterizes the liquid-liquid interface. When diffusional resistance terms are defined in the usual manner, three classes of interfacial diffusion may be conveniently described by our model. It is found that extraordinary resistance to diffusion at the interface gives rise to perturbations in the observed concentration profile of the bulk regions; these perturbations diminish with time and disappear in the limit of vanishing resistance. (auth)

5136

SOLID OZONE. Callaway Brown, Abraham W. Berger, and Charles K. Hersh (Illinois Inst. of Tech., Chicago). *J. Chem. Phys.* **22**, 1151-2(1954) June.

It has been found that solidified ozone may be formed by vacuum distillation into a container cooled to the triple point of  $N_2$  (-210°C). Once formed the material does not become fluid in a liquid nitrogen bath, but two observations with a nitrogen bath warmed slowly by the addition of oxygen showed a transition to the fluid form at  $-193 \pm 0.5^\circ C$ . The obvious interpretation of these observations is that liquid ozone supercools readily and is normally fluid at  $-195^\circ$  but that the true melting point is  $-193^\circ \pm 0.5^\circ C$ . (J.A.G.)

5137

THE SPEED OF DISSOLUTION OF IRON AND ALUMINUM IN WATER SOLUTIONS OF HYDROCHLORIC ACID. T. G. Owe Berg. *J. chim. phys.* **51**, 141-60(1954) Apr. (In French)

The speed of the dissolution of impure Fe and Al in aqueous solutions of HCl was measured between 0 and 65° and between 1 and 13N. The empirical relationships among the speed of dissolution  $v$ , acid concentration  $c$ , and the temperature  $T$  were determined. For Fe the empirical formula is  $v = A (mc)^2 / c \alpha^{1/2} T^{1/2} \exp(-E/RT)$  where  $mc$  is the water concentration and  $\alpha$ , the degree of ionization of the acid. The energy of activation is  $E = 15.0 - 0.455c$  kcal/mole. The process which determines the speed of dissolution is the hydrolysis of  $FeCl_2$ . The part of the surface of the metal covered with  $FeCl_2$  is determined by an equilibrium between the surface reactions and reactions in the solution. It is proportional to the square root of the speed of adsorption of ionized HCl molecules. For Al, the speed follows different laws for different ranges of concentration, but  $v$  is proportional to  $c^2$ . It was concluded that the speed of dissolution was determined by the dissolution of  $Al(OH)_3$ . The energy of activation is independent of  $c$ . The speed of dissolution is determined also by the removal of H adsorbed on the surface of the metal. With  $c = 10.1N$   $v$  decreases suddenly by a factor from 10 to 100, because of the adsorption by the metal of the nonionized HCl molecules which do not react with Al. (tr-auth)

5138

ON LOW VALENT THORIUM COMPOUNDS. G. Jantsch, J. Homayr, and F. Zemek. *Monatsh. Chem.* **85**, 526-36 (1954) June. (In German)

$ThCl_4$  and the lower valent halides were prepared by thermal and isobaric decomposition and by reduction with metallic Th and Al powders. The results were compared with those of earlier workers. (tr-auth)

5139

HIGH PURITY SILICON. Felix B. Litton and Holger C. Andersen (Foote Mineral Co., Berwyn, Penna.). *J. Electrochem. Soc.* **101**, 287-92(1954) June.

Thermal decomposition of silicon tetraiodide was in-

vestigated in both standard iodide (de Boer) and intermittent flow systems for potential use as a method for preparing high-purity silicon metal. Purity of metal obtained from operation of a standard iodide process cell appeared to be a function of impurities in crude silicon source material. Iodide metal having resistivities from 0.5 to 3 ohm-cm in the single crystal form was produced from Electro-Metallurgical high-purity silicon. When iodide metal was used as silicon source material, the resistivity of single crystals of double refined metal varied from 3 to 8 ohm-cm. Silicon of higher purity was obtained through thermal decomposition of fractionally distilled silicon tetraiodide in an intermittent flow system. After preparation of tetraiodide by reaction of resublimed iodine and Electro-Metallurgical high-purity silicon, it was subjected to a 16-step distillation at 200 mm pressure in a packed quartz column. The modified iodide process silicon was p-type, and the resistivity varied in seven preparations from 30 to 200 ohm-cm. (auth)

#### ANALYTICAL PROCEDURES

5140

Armour Research Foundation  
SEPARATION AND DETERMINATION OF SILICON, TUNGSTEN, TITANIUM, NIOBIUM AND TANTALUM IN OXIDE MIXTURES. FINAL REPORT. W. A. Dupraw. Oct. 19, 1953. 47p. Contract AF-33(038)-21505. (AD-21216)

A simple analytical procedure is presented for effectively separating and quantitatively determining silica when present in oxide combination with the oxides of tantalum, niobium, titanium, and tungsten. This procedure employs the complexing properties of oxalates to effectively permit the extraction of tantallic, niobic, titanic, and tungstic oxides after a pyrosulfate fusion of the combined oxides. The silica remains insoluble and uncontaminated and may be recovered by filtration. An effective separation, within the scope investigated, is submitted; it permits the quantitative determination of tantalum when present in oxide combination with niobium, tungsten, and titanium after the silica has been previously removed from the oxide combination. Tannic acid and *n*-propyl arsonic acid are employed to effect this separation in oxalate solution containing 5 per cent sulfuric acid. This separation is, apparently, ineffective when large percentages of titanium are present. Experiments employing exchange resins to effect the separation of macro quantities of titanium, niobium, and tantalum indicate the possibility of using exchange resins in various anionic forms to effect the desired separations. (auth)

5141

DuPont de Nemours, E. I., and Co. Explosives Dept., Atomic Energy Div.  
COLORIMETRIC  $H_2S$  DETECTOR. T. F. Parkinson. Apr. 1954. 23p. Contract AT(07-2)-1. (DP-46)

A semi-portable instrument has been built and tested which utilizes a colorimetric method for quantitatively detecting concentrations of  $H_2S$  in air as low as 10 ppm (by volume). Color changes in a moving reactive tape are measured photometrically. Initial response time is less than 5 seconds and results are reproducible to about  $\pm 25\%$ . The output from the instrument can be fed to a recording potentiometer and provision is made for actuating an alarm or other external circuit when a specified concentration is reached. The instrument operates from 110v a-c and weighs about 30 pounds. (auth)

5142

American Cyanamid Co., Atomic Energy Div., Idaho Falls, Idaho  
OPERATING MANUAL, CHEMICAL DEPARTMENT. PART



8. METHODS OF ANALYSIS. R. D. Divine, J. R. Kelley, J. W. Casper, and S. L. Sly. Apr. 29, 1952. Decl. Feb. 8, 1954. 73p. Contract AT(10-1)-177. (IDO-14072)

5143

Mound Lab.

A POLAROGRAPHIC METHOD FOR THE DETERMINATION OF MICROGRAM AMOUNTS OF IRON AND FLUORIDE.

Carlyle E. Shoemaker. Dec. 22, 1953. 24p. Contract AT-33-1-GEN-53. (MLM-910)

Methods of analysis for microgram amounts of iron and fluoride using a rotating platinum microelectrode were developed from a polarographic study of the ferric fluoride complexes. Fluoride ion forms complexes with ferric iron, reducing its concentration; the iron fluoride complex is reduced irreversibly at potentials more negative than the reduction of ferric iron. The dissociation constant of  $\text{FeF}^{+2}$  was found to be  $6.9 \times 10^{-6}$ . One microgram of fluoride and one-third microgram of iron can be determined with an accuracy of about 10 per cent. Borates and relatively large amounts of chloride interfere with the determination of fluoride. (auth)

5144

THE ABSORPTIOMETRIC DETERMINATION OF NIOBIUM IN SOME AFRICAN LOW-GRADE MINERALS AND MINERAL-DRESSING PRODUCTS. G. W. C. Milner and A. A. Smales (Atomic Energy Research Establishment, Harwell, Berks, England). *Analyst* 79, 315-26(1954) June.

A method is described for the determination of 0.05% to at least 16% of niobium pentoxide in head samples and mineral-dressing fractions produced during treatment of Sukulu soils (mainly magnetite, apatite, and quartz) and Nigerian granite (mainly quartz and cryolite). After chemical attack on the sample, the niobium is separated from the bulk of the other materials by precipitation with tannic acid and cinchonine with silica as carrier and is finally determined absorptiometrically with potassium thiocyanate. The separation steps need not be quantitative because radiometric correction for losses is made by incorporating  $\text{Nb}^{85}$  tracer in the procedure. (auth)

5145

THE ABSORPTIOMETRIC DETERMINATION OF NIOBIUM IN LOW-GRADE ORES. A. E. O. Marzys (Uganda Development Corp. Ltd., Entebbe, Africa). *Analyst* 79, 327-38(1954) June.

The absorption of light in the near ultraviolet by the reduced niobium thiocyanate complex in an organic medium is made a basis for the determination of niobium in low-grade ores and minerals. The respective merits of a water-acetone mixture and of ether as solvents are described. The method has been adapted for use with a Hilger Spekker absorptiometer provided with a mercury-vapor lamp. Four modifications of the main procedure are described for use in the presence of certain interfering elements. The results for a variety of African soils and minerals are compared with those found by gravimetric methods. The precision of the method is as good as, and probably better than, that of gravimetric methods when applied to complex soils and rocks of low niobium content. The speed and ease of manipulation are greatly increased. By suitable adjustment of the amounts of material used, the method can, in the absence of vanadium, be extended to all niobium minerals. The ratio of niobium to tantalum in mixed oxides can be rapidly found by determining niobium and titanium colorimetrically and calculating the tantalum content by difference. (auth)

5146

INORGANIC CHROMATOGRAPHY ON CELLULOSE. PART XIV. A SHORTENED CHROMATOGRAPHIC METHOD FOR THE DETERMINATION OF NIOBIUM

AND TANTALUM IN MINERALS AND ORES. R. A. Mercer and R. A. Wells (Chemical Research Lab., Teddington, Middlesex, England). *Analyst* 79, 339-45 (1954) June.

A chromatographic procedure is described for the extraction of the mixed oxides of tantalum and niobium from minerals and ores. A solution of the sample in hydrofluoric acid containing ammonium fluoride is absorbed on cellulose and transferred to a 3-inch column of cellulose. The niobium and tantalum are completely extracted on passing 400 ml of ethyl methyl ketone containing 15% v/v of 40% w/v hydrofluoric acid through the column. The separation is complete from all metals other than tungsten. The two oxides, recovered from this solvent, are subsequently separated by further chromatography or determined without separation by a suitable colorimetric procedure. (auth)

5147

INORGANIC CHROMATOGRAPHY ON CELLULOSE.

PART XV. A RAPID CHROMATOGRAPHIC METHOD FOR THE DETERMINATION OF NIOBIUM IN LOW-GRADE SAMPLES. E. C. Hunt and R. A. Wells (Chemical Research Lab., Teddington, Middlesex, England). *Analyst* 79, 351-9(1954) June.

A rapid and simple chromatographic method is described for the determination of niobium in a hydrofluoric acid solution of an ore by upward diffusion on a paper strip. The niobium is detected as a yellow band on spraying the strip with aqueous tannic acid. An accurate determination of niobium is made by direct visual comparison of the band with standard strips. The chromatographic separation takes 20 minutes, and a simple technique is described for carrying out ten separations simultaneously. The accuracy is 10% on ores containing more than 0.10% of niobium pentoxide. (auth)

5148

THE VOLUMETRIC DETERMINATION OF ALUMINIUM IN NON-FERROUS ALLOYS. G. W. C. Milner and J. L. Woodhead (Atomic Energy Research Establishment, Harwell, Berks, England). *Analyst* 79, 363-7(1954) June.

The determination of aluminium can readily be accomplished by a volumetric procedure involving the addition of an excess of a standard ethylenediaminetetraacetic acid solution to the aluminium solution followed by titrating the reagent unused in the formation of the aluminium-ethylenediaminetetraacetic acid complex. A standard iron solution is used for this titration, and salicylic acid is a suitable indicator for showing the titration end point. With this procedure it is possible to determine up to 60 mg of aluminium with an accuracy of better than  $\pm 1\%$ . This titration has proved advantageous in the rapid analysis of various nonferrous materials including copper, zinc, and magnesium-base alloys after the preliminary separation of the aluminium as its insoluble benzoate. (auth)

5149

ASSAY OF  $\text{C}^{14}$  IN THE GAS PHASE AS CARBON DIOXIDE. J. E. S. Bradley, R. C. Holloway, and A. S. McFarlane (National Inst. of Medical Research, London). *Biochem. J.* (London) 57, 192-5(1954) June.

A technique is described for the assay of  $\text{C}^{14}$  using  $\text{CO}_2$ . The gas obtained by microanalytical combustion is purified by contact with hot Cu filament, and its radioactivity assayed in the proportional region without admixture. (auth)

5150

OPTICAL SPECTROSCOPIC DETERMINATION OF HYDROGEN ISOTOPES IN AQUEOUS MIXTURES.

Herbert P. Broida, Harold J. Morowitz, and Margaret



Selgin (National Bureau of Standards, Washington, D. C.). *J. Research Nat. Bur. Standards* 52, 293-301(1954) June.

Extension of the optical spectroscopic method of isotope analysis of gaseous mixtures of hydrogen and deuterium to mixtures of water and heavy water provides a direct method for determining the total water content of materials. A determination can be made on a sample of less than 0.1 milliliter in less than 10 minutes to an accuracy of a few percent. Using a sample of at least 1 milliliter, an accuracy of the order of 0.1 percent is obtained in an hour or less. This paper describes the system and the investigation of optimum operating conditions and effect of variations in operating conditions on precision and accuracy of measurement, as well as limitations of the technique. A sample of blood or serum can be measured directly almost as easily as one of distilled water. The optical spectroscopic method can be used to determine the water content of most materials, whether in the solid, liquid, or gas phase. (auth) (cf. NBS-3064.)

5151

ANALYSIS OF URANIUM IN SEA WATER. D. C. Stewart and W. C. Bentley (Argonne National Lab., Lemont, Ill.). *Science* 120, 50-1(1954) July 9.

A method is described for concentrating U in sea water by extracting the U directly into an organic solvent containing dibutyl-orthophosphoric acid. Data for analysis of Pacific Ocean water for U are compared with data obtained by other methods. (C. H.)

5152

THE DETERMINATION OF NITROGEN IN COPPER-TITANIUM ALLOYS. Maurice Codell and Frank D. Verderame (Pittman-Dunn Lab., Frankford Arsenal, Philadelphia.) *Anal. Chem. Acta* 11, 40-7(1954) July.

A rapid and accurate method is proposed for determining nitrogen in copper-titanium alloys which is satisfactory for quantities of nitrogen as low as 0.01%. In the development of the procedure, a study was made of possible digestion solutions. A moderately concentrated solution of perchloric acid was found to be most practical for decomposing the sample. When solution of the sample is completed, the mixture is transferred to the flask of a micro-Kjeldahl distillation apparatus. Sodium hydroxide is added until the solution is distinctly alkaline, and the liberated ammonia is steam distilled into a solution of boric acid and titrated with standard acid. (auth)

5153

RAPID DETERMINATION OF THORIUM IN ORES. I. SEPARATION AS IODATE IN PRESENCE OF OXALIC ACID. Mahadeo M. Tillu and V. T. Athavale (Atomic Energy Commission, Bombay). *Anal. Chim. Acta* 11, 62-7(1954) July.

It is shown that thorium can be precipitated quantitatively in 40% nitric acid solution as iodate, in presence of oxalic acid which complexes all those elements that interfere seriously in the usual iodate procedure. Thorium is thus freed from all the cations in a single operation from solutions containing sulfate and phosphate radicals. The method is very quick and thorium oxide in a sample of monazite could be estimated with precision in 8 to 9 hours. (auth)

5154

DETERMINATION OF LOW CONCENTRATIONS OF OXYGEN IN HYDROGEN. M. M. Wright (Consolidated Mining and Smelting Co. of Canada, Ltd., Trail, B. C.). *Anal. Chem.* 26, 1001-8(1954) June.

Oxygen in hydrogen can be determined by the formation of water vapor on a platinum catalyst followed by separation by condensation at the liquid nitrogen temperature and measurement of the volume at 10-mm pressure. The

method is standardized to take into account the adsorption of water vapor on the glass apparatus. The lower limit in the apparatus is 0.00005% oxygen on a 1.3-liter sample with an error of  $\pm 10\%$ . The error decreases as the concentration increases, becoming  $\pm 2\%$  above 0.002% oxygen. The sensitivity and accuracy of the method are illustrated in the determination of current efficiency in the electrolytic formation of oxygen between platinum electrodes in sulfuric acid. The current efficiency rises from 53 to 93% between 10 and 68  $\mu\text{a}$ . (auth)

5155

INFRARED ABSORPTIOMETRY FOR QUANTITATIVE DETERMINATION OF BORON HYDRIDES IN PRESENCE OF PENTABORANE. Lewis V. McCarty, George C. Smith, and Robert S. McDonald (General Electric Research Lab., Schenectady, N. Y.). *Anal. Chem.* 26, 1027-31(1954) June.

Data are presented for the infrared absorptiometric determination of the four component system containing diborane, tetraborane, and dihydropentaborane in a relatively larger amount of pentaborane. The data are combined into equations which permit the direct calculation of the pressure in mm for each boron hydride from measurements of the absorbance, D, at four wave lengths.

$$P_{B_2H_6} = -0.58 D_{4.05} + 0.52 D_{4.65} - 3.49 D_{5.54} + 14.81 D_{6.15}$$

$$P_{B_4H_{10}} = -3.64 D_{4.05} + 68.55 D_{4.65} - 1.45 D_{5.54} + 0.47 D_{6.15}$$

$$P_{B_5H_{11}} = -7.25 D_{4.05} + 14.65 D_{4.65} + 164.10 D_{5.54} + 0.45 D_{6.15}$$

$$P_{B_5H_{11}} = 39.86 D_{4.05} - 74.85 D_{4.65} + 2.48 D_{5.54} - 5.12 D_{6.15}$$

At a total pressure of 100 mm the minimum detectable amount of diborane is about 0.2 mole %; for tetraborane it is about 0.6 mole %; and for dihydropentaborane it is about 0.7 mole %. (auth)

5156

VOLUMETRIC METHOD FOR THE DETERMINATION OF ZIRCONIUM. Mulk Raj Verma and Sukh Deo Paul (National Physical Lab. of India, Hillside Road, New Delhi). *Nature* 173, 1237(1954) June 26.

A volumetric method for the determination of Zr by the oxidation of p-chloro- and p-bromomandelic acids precipitated from a known volume of Zr tetra-p-chloro- or bromomandelate by  $\text{Ce}(\text{SO}_4)_2$  is presented. Results of the determination obtained on 2ml each of a  $\text{H}_2\text{SO}_4$  solution of Zr oxide are tabulated. (J.A.G.)

5157

QUANTITATIVE DETERMINATION OF ALUMINUM IN SILICA GEL, ACTIVATED BY ALUMINUM OXIDE. K. G. Miessarov. *Zhur. Priklad. Khim.* 27, 677-80(1954) June. (In Russian).

The coupling of Si-O-Al in Al-silica gel is easily destroyed by the action of acid salts. Complete recovery of all chemically bound Al can be obtained by treatment of Al-silica gel with a normal solution of cold HCl with the subsequent determination of Al. If the samples contain  $\text{Al}_2\text{O}_3$ , complete recovery of Al is obtained by treatment of the sample with boiling normal HCl. (tr-auth)

#### ATOMIC WEIGHTS AND PERIODIC SYSTEMS

5158

PRINCIPLE CONSIDERATIONS IN THE PERIODIC SYSTEM OF ELEMENTS. RELATIONSHIP BETWEEN THE ATOMIC NUCLEUS AND THE ATOMIC SHELL. Richard Lepsius and S. K. Asunmaa. *Naturwissenschaften* 10, 19-29(1954). Jan.

The relationship between the nucleus and the atomic shell was discussed on the basis of a graphic-tabular compilation of stable isotopes. (J.S.R.)

5159

ON THE QUESTION OF THE RELATIONSHIP BETWEEN



HEAT GENERATION OF CHEMICAL COMPOUNDS AND THE POSITION OF THE ELEMENTS IN THE MENDELEEV TABLE. V. P. Shishokin (Leningrad State Inst. im. M. I. Kalinin, Russia). *Zhur. Obschei Khim.* **24**, 745-51(1954) May. (In Russian)

As the heat generation by chemical compounds changes in most cases periodically both with the group and with the period, the presence of periodicity in the variation of thermal generation can not be practically confirmed. However, the thermal generation has an inverse relationship with the ionization potential of cations and a linear relationship with the ionization potential of anions. The linear relationship has a different form for different groups of compounds, which is caused by the different nature of the bond in the compound. The regularities are applicable both for gases and for solid-state materials. From the regularities the order of heat generation by chemical compounds can be calculated, and corrections can be introduced in the experimental data. A linear relationship exists between the atomic number and the square root of the equivalent ionization potential of elements. (tr-auth)

#### CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE

5160

CRYSTAL STRUCTURE OF POTASSIUM PERRUTHENATE,  $\text{KRuO}_4$ . Meyer D. Silverman and Henri A. Levy (Oak Ridge National Lab., Tenn. and Univ. of Tennessee, Knoxville). *J. Am. Chem. Soc.* **76**, 3317-19(1954) June 20.

The crystal structure of potassium perruthenate has been determined to be of the scheelite type, space group  $C_{4h}^2-I_{41}/a$ ; the unit cell, containing four molecules of  $\text{KRuO}_4$ , has the dimensions  $a_0 = 5.609 \pm 0.002$  Å and  $c_0 = 12.991 \pm 0.002$  Å. The atomic positions are Ru at (000), K at  $(0, 0, \frac{1}{2})$ , O at (xyz) and crystallographically equivalent positions with  $x = 0.244$ ,  $y = 0.117$ ,  $z = 0.073$ , accurate to about 0.002. The ruthenium coordination is a tetrahedron slightly flattened along the c-axis, with a Ru-O distance of 1.79 Å. (auth)

#### DEUTERIUM AND DEUTERIUM COMPOUNDS

5161

THE DENSITY, SURFACE TENSION AND VISCOSITY OF DEUTERIUM OXIDE AND ELEVATED TEMPERATURES. J. R. Heiks, M. K. Barnett, L. V. Jones, and E. Orban (Mound Lab., Miamisburg, Ohio). *J. Phys. Chem.* **58**, 488-91(1954) June.

The density and viscosity of 99.20% deuterium oxide have been determined from 30 to 250° while surface tension measurements were made from 100 to 216°. A bob suspended from a 200-micron fused quartz fiber spiral inside of a pressure vessel was used to determine the densities to the nearest 0.0003 g/cc. The ratio of the densities of deuterium oxide to ordinary water increases with temperature up to about 80° but decreases with still further increases in temperature. A Lawaczeck falling body viscometer, in which the time of fall of a radioactive plummet was measured with the use of coincident counting tubes, showed the viscosity of deuterium oxide to be 21% higher than ordinary water at 30°, while at 250° this difference decreased to 9.7%. The height of rise of liquid in a capillary tube showed that the surface tension of deuterium oxide and ordinary water are about the same at 100°, but with increasing temperature the surface tension for deuterium oxide becomes steadily less until at 220° it is about 3% less than the value for ordinary water. (auth)

5162

DEUTERIUM EFFECT ON HYDROGEN BOND DISTANCES IN HAFNIUM DIHYDRIDE. S. S. Sidhu (Argonne National Lab., Lemont, Ill.). *J. Chem. Phys.* **22**, 1062-3(1954) June.

X-ray-diffraction data obtained for carefully prepared and annealed samples of  $\text{HfH}_2$  and  $\text{HfD}_2$  show that as deuterium substitutes for hydrogen atoms the hafnium-hydrogen bond distances decrease. The lattice as a whole contracts, and the density increases. Powder diffraction patterns and the structure data for the two compounds are presented. (auth)

5163

PROPERTIES AND STRUCTURES OF THE PEROXIDES OF HYDROGEN AND DEUTERIUM. P. A. Giguere (Univ. Laval, Quebec, Canada). *Bull. soc. chim. France*, 720-3(1954) June. (In French)

The physical properties of  $\text{H}_2\text{O}_2$  and  $\text{D}_2\text{O}_2$  are compared. The molecular structures of the two compounds are discussed, but the configurations are not yet proved. (J.S.R.)

#### FLUORINE AND FLUORINE COMPOUNDS

5164

THERMAL AND X-RAY ANALYSIS OF THE SYSTEM  $\text{LiF}-\text{BeF}_2$ . A. V. Novoselova, Yu. P. Simanov, and Ye. I. Yarembash. Translated from *Zhur. Fiz. Khim.* **26**, 1244-58(1952). 37p. (AEC-tr-1838)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 8-767.

5165

THE SOLUBILITIES OF SULFUR HEXAFLUORIDE IN WATER AND OF THE RARE GASES, SULFUR HEXAFLUORIDE AND OSMIUM TETROXIDE IN NITROMETHANE. Harold L. Friedman (Univ. of Southern California, Los Angeles). *J. Am. Chem. Soc.* **76**, 3294-7(1954) June 20.

The following gas solubilities (Ostwald coefficients) have been determined at 25° with an accuracy of about 3%: in water,  $\text{SF}_6 = 0.0055$ ; in nitromethane,  $\text{He} = 0.0175$ ,  $\text{Ne} = 0.0245$ ,  $\text{Ar} = 0.145$ ,  $\text{Kr} = 0.380$ ,  $\text{Xe} = 1.14$ ,  $\text{SF}_6 = 0.377$ ,  $\text{OsO}_4 = 1100$ . The  $\text{OsO}_4$  value was obtained indirectly by studying the partition of  $\text{OsO}_4$  in nitromethane-water mixtures. The solubilities of  $\text{SF}_6$  also have been measured at lower temperatures. Sulfur hexafluoride exhibits the lowest solubility in water at 25° of any gas known, owing to an abnormally large entropy decrease upon forming the solution. Rough agreement with the regular solution theory is exhibited by these substances in nitromethane. It is found that the 25° solubilities of the rare gases in a variety of solvents, including water, may be correlated by the equation  $\log x = a + bg$  where  $x$  is the solubility and  $a$  and  $b$  depend only upon the solvent and  $g$  depends only upon the gas. This correlation is accurate to  $\pm 5\%$  in the solubility. (auth)

5166

THE FORCE CONSTANTS AND BOND LENGTHS OF SOME INORGANIC HEXAFLUORIDES. J. Gaunt (Atomic Energy Research Establishment, Harwell, Berks, England). *Trans. Faraday Soc.* **50**, 546-51(1954) June.

The force constants of a number of inorganic hexafluorides have been calculated using the frequency formulas worked out by Heath and Linnett. It has been shown that the mutual repulsion between the nonbonded fluorine atoms gives rise to an elongation of the X—F bonds, and attempts to calculate this elongation have been made. A modified form of Badger's relationship between the force constants and bond lengths has been established for a number of spherical molecules and has been used to predict those bond lengths which were hitherto unknown. (auth)

5167

FLUORIDE DETERMINATION BY ELECTRON TRANSFER CATALYSIS. W. D. Armstrong and Leon Singer (Univ. of Minnesota, Minneapolis). *Anal. Chem.* **26**, 1047-9(1954) June.

The marked catalytic effect of fluoride on the cerous-



ceric electron exchange reaction suggested that this reaction could be used as a microanalytical method for fluoride determination without the necessity of removing ions which interfere in present methods. Cations in general were found to exert negligible catalytic effects. The catalytic effect of fluoride was about 900 times that of sulfate and about 370 times that of phosphate. These circumstances limit the application of the method to those samples which do not contain these ions or in which the effect of the interfering ions can be made constant. The fluoride content of bone ash has been determined by making constant the effect of interfering ions. The results of electron transfer catalysis by various negative ions are considered to be in qualitative agreement with Libby's description of the mechanism of electron transfer catalysis. (auth)

## LABORATORIES AND EQUIPMENT

5168

Livermore Research Lab., Calif. Research and Development Co.

REMOTE RADIOACTIVITY MATERIALS TESTING LABORATORY AT LIVERMORE RESEARCH LABORATORY. R. V. Steele. June 1954. 12p. Contract AT(11-1)-74. (LRL-150)

The two metallurgical hot-cell facilities at the Livermore Research Laboratory are described. The remote handling and remote testing equipment are also discussed. (auth)

5169

Oak Ridge National Lab.

GRAPHITE AND ALUMINUM-BLOCK, SOLUTION EVAPORATORS. C. D. Susano. June 4, 1954. 12p. Contract W-7405-eng-26. (ORNL-1735)

Equipment has been designed and fabricated which speeds up the evaporation of solutions contained in crucibles, casseroles, and dishes without loss due to localized overheating. Evaporators are fabricated from solid aluminum metal or graphite blocks by the simple process of making apertures in the material so that the vessel is held above the liquid level, at a distance of  $\frac{1}{8}$  to  $\frac{1}{4}$  inch above the surface of the heating unit. Evaporators made out of solid graphite are more efficient than similar evaporators made out of solid or sheet aluminum metal. (auth)

## MOLECULAR STRUCTURE

5170

STRUCTURES OF THE BORON HYDRIDES. William N. Lipscomb (Univ. of Minnesota, Minneapolis). *J. Chem. Phys.* 22, 985-8(1954) June.

Evidence for the structures of  $B_2H_6$ ,  $B_4H_{10}$ ,  $B_5H_{11}$ , and  $B_{10}H_{14}$  is reviewed. Correlations of the boron arrangements with known structures have been pointed out, and a systematic discussion of the boron-hydrogen distances is given. (auth)

5171

THE VALENCE STRUCTURE OF THE BORON HYDRIDES. W. H. Eberhardt (Georgia Inst. of Tech., Atlanta), Bryce Crawford, Jr., and William N. Lipscomb (Univ. of Minnesota, Minneapolis). *J. Chem. Phys.* 22, 989-1001(1954) June.

A set of extended valence postulates is presented including the concept of the localized three-center bond. These postulates are applied systematically to the boron hydrides and account for their unusual geometry, their unexpected dipole moments, and the fact that they are not "electron-deficient." (auth)

5172

SYMBOLIC STRUCTURAL FORMULAS FOR BORON HYDRIDES. John R. Platt (Univ. of Chicago). *J. Chem. Phys.* 22, 1033-6(1954) June.

A structural convention is proposed, intended to serve the same function for boron hydrides that the standard valence bond convention serves for organic compounds. It involves the auxiliary concept of the valence cone, which is the cone swept out by three tetrahedral orbitals rotating about the fourth as an axis. The known open boron hydrides  $B_nH_{n+p}$  then appear to be even-electron molecules with the boron atoms approximately in a close-packed equilateral-triangular network on the convex surface formed by their overlapping valence cones; with  $n$  single B-H bonds normal to this surface; and with  $p$  (even) added peripheral hydrogen in the surface located so that every boron atom has neighbors in all three sectors of its valence cone. As long as this network does not form a complete polyhedron, we may represent it on paper by a flat triangular network having the same topology. This prescription gives uniquely and correctly the structures and formulas for the known  $B_2$ ,  $B_4$ ,  $B_5$ ,  $B_6$ , and  $B_{10}$  hydrides and predicts other possible open compounds up to  $B_{11}$ . It would be consistent with the existence of closed inert polyhedral hydrides  $B_nH_n$  up to  $B_{12}H_{12}$  and with chains and lattices of such polyhedra. (auth)

5173

MODIFICATION OF THE NAIVE MO METHOD. Lionel Goodman and Harrison Shull (Iowa State Coll., Ames). *J. Chem. Phys.* 22, 1138(1954) June.

A procedure is outlined for combining the naive empirical MO method, in which the orbital energies of a conjugated hydrocarbon are obtained by solution of an appropriate secular equation, and the ASMO method for obtaining a transition energy for the process  $a \rightarrow b$  utilizing the ground state Hamiltonian for the excited state as well as the closed-shell ground state. This procedure of complementing the naive semiempirical approach with theoretically computed repulsion integrals may be applied to substituted hydrocarbons. (J.A.G.)

5174

A SEMIEMPIRICAL TREATMENT OF  $n-\pi$  TRANSITIONS. Lionel Goodman and Harrison Shull (Iowa State Coll., Ames). *J. Chem. Phys.* 22, 1138-9(1954) June.

The special case of a transition from a nonbonding( $n$ ) orbital to an antibonding  $\pi_x$  orbital is treated by using the method of the preceding abstract. Equations for the energy of transition, for the expansion of the integrals over MO's into integrals over AO's, and for the expansion of the MO integrals in the usual oscillator strength formula into AO integrals are given. From these the  $n-\pi$  transition energies can be computed, and oscillator strengths obtained completely independently from  $\pi-\pi$  spectra. (J.A.G.)

## RADIATION CHEMISTRY

5175

DIFFUSION KINETICS OF ATOM-RADICAL RECOMBINATION IN RADIATIVE NEUTRON CAPTURE BY HALOGENS IN LIQUID ALKYL HALIDES. J. C. Roy, R. R. Williams, Jr., and W. H. Hamill (Univ. of Notre Dame, Indiana). *J. Am. Chem. Soc.* 76, 3274-8(1954) June 20.

The effects of added halogens and haloolefins have been measured upon distribution of halogen radioactivity between organic and inorganic components following neutron capture in some alkyl halides. A simple, approximate treatment of atom-radical dissociation-recombination by diffusion is proposed to explain these effects. It is postulated that each nuclear process produces effectively one atom-radical pair, and decreased recombination due to added halogen results from competition with diffusion-controlled recombination. A different type of mechanism is proposed to account for the effects of added haloolefins



in liquid alkyl halides since the olefins are effective at mole fractions  $10^{-7}$  to  $10^{-4}$  compared to  $10^{-4}$  to  $10^{-2}$  for halogens. For ethyl bromide-dibromoethylene the competing reactions would be:  $C_2H_2Br_2 + Br^* \rightarrow C_2H_2BrBr^* + Br$ ;  $C_2H_5Br + Br^* \rightarrow C_2H_4Br + HBr^*$ . The results indicate an activation energy difference of ca. 11 kcal. (auth)

5176

THE YIELDS OF HYDROGEN AND HYDROGEN PEROXIDE IN THE IRRADIATION OF OXYGEN SATURATED WATER WITH COBALT GAMMA-RAYS. J. A. Ghormley and C. J. Hochanadel (Oak Ridge National Lab., Tenn.). *J. Am. Chem. Soc.* 76, 3351-2(1954) June 20.

Hydrogen and  $H_2O_2$  yields from  $\gamma$  irradiation of oxygen-saturated water in ampoules having no gas space were measured, as well as  $H_2O_2$  yields from water through which oxygen was continuously swept during irradiation in order to remove the  $H_2$  produced. When the secondary reaction of  $H_2$  with OH was prohibited by the presence of KBr, the yield of  $H_2$  was 0.21 greater than when the secondary reaction was allowed to proceed. The yield of  $H_2O_2$  in oxygen-saturated water in closed vessels was 0.21 more than when the  $H_2$  produced was swept away by oxygen. Thus, the  $H_2O_2$  formed through secondary reaction of the  $H_2$  was equivalent to the  $H_2$  used up. These results are compared briefly with those of other investigators. (A.G.W.)

5177

CHEMICAL PRIMARY PROCESSES IN THE ACTION OF IONIZING RADIATIONS ON WATER: EVIDENCE FROM EXPERIMENTS WITH HEAVY WATER. Patrick Kelly, Tyson Rigg, and Joseph Weiss (King's Coll., Newcastle upon Tyne, England). *Nature* 173, 1130-2(1954) June 12.

An experiment was designed which could distinguish between the hydrogen gas formed by the recombination of hydrogen atoms and the hydrogen molecules formed directly in a single elementary process. It was found that such information can be derived from a study of the isotopic composition of the hydrogen gas which is given off from water, enriched with heavy hydrogen, under the influence of ionizing radiations. (L.T.W.)

5178

OXIDATION AND REDUCTION OF AQUEOUS FERROUS-FERRIC SULFATE INDUCED BY VISIBLE LIGHT ABSORPTION OF MERCURIC SULFIDE. Leonard I. Grossweiner and Sheffield Gordon (Argonne National Lab., Lemont, Ill.). *J. Chem. Phys.* 22, 1139-40(1954) June.

The oxidation and reduction of aqueous ferrous-ferric sulfate (0.8N  $H_2SO_4$ ) induced by light absorption by a suspension of  $HgS$  powder at  $18^\circ C$  are discussed. Dose curves for air-saturated solutions and a comparison of the yields with NaCl (1.0mM/liter) and  $HCOOH$  (1.0mM/liter) additives and He, air, and  $O_2$  gases bubbling through the solutions are given. No free S was found in irradiated solutions. The effect of the spectral distribution of incident light on the reduction of air-saturated ferric sulfate is given. A tentative scheme for the conversions is suggested. A reaction not significant in  $\gamma$ -ray-induced reactions at this pH was the reduction of ferric ion. The average conversion efficiency for reduction of air-saturated ferric sulfate was  $630 \pm 95$  incident photons/ferric ion reduced. The highest efficiency found was that for oxygen-saturated ferrous sulfate,  $280 \pm 40$  incident photons/ferrous ion oxidized. (J.A.G.)

5179

RADIATION CHEMISTRY OF LUMINESCENT SOLUTIONS. Milton Burton and W. N. Patrick (Univ. of Notre Dame, Indiana). *J. Chem. Phys.* 22, 1150(1954) June.

An investigation of the protective effect of solutions of *p*-terphenyl, *m*-terphenyl, and anthracene in inhibition of chemical decomposition of benzene exposed to  $\gamma$ irradiation

is discussed. Results indicate that neither *p*-terphenyl nor anthracene confers any perceptible protection on benzene. A protective effect of *m*-terphenyl at 7.32 electron % was found. (J.A.G.)

5180

QUANTITATIVE STUDIES OF RADIATION-INDUCED REACTIONS. PART 2. THE OXIDATION OF FERROUS SULPHATE BY ALPHA-PARTICLES. N. Miller and J. Wilkinson (Univ. of Edinburgh, Scotland). *Trans. Faraday Soc.* 50, 690-710(1954) July. (cf. NSA 4-1696).

A study has been made of the oxidation of ferrous sulfate solutions by the  $\alpha$ -rays from  $Po^{210}$ . In oxygen-containing solution this is found to proceed with a yield of about 5.9 ferric ions per 100 ev of  $\alpha$ -particle energy released in the solution, independent of the ferrous concentration between 0.6 and 10 millimolar. In air-free solution the yield is lower by a factor 1.7 and is not as sensitive to the pH or the ferric concentration as with  $\gamma$ -radiation. Studies of the hydrogen evolution accompanying the oxidation in aerated solution reveal that 82 water molecules are decomposed to give "molecular" products for every 18 giving radical pairs  $H + OH$ . The unexpectedly large effect of de-aeration and the lack of pH dependence in air-free solution are both explained if it is postulated that the H atoms formed in the particle tracks recombine to give  $H_2$  in the absence of molecular oxygen, rather than react with  $H^+$  to give  $H_2^+$ , as occurs in the more diffuse tracks of fast electrons. Other possible complications of a more physical nature are discussed. (auth)

5181

STUDY OF THE RADIOLYSIS OF DILUTE SOLUTIONS OF DIPHENYLPICRYLHYDRAZYL IN ORGANIC SOLVENTS. II. THE SPATIAL DISTRIBUTION OF THE PRIMARY FREE RADICALS. A. Chapiro (Laboratoire de Chimie Physique, Paris, France). *J. chim. phys.* 51, 165-77(1954) Apr. (In French) (cf. NSA-8-1329)

The kinetic study of the radiolysis by x and  $\gamma$  rays of dilute solutions of diphenylpicrylhydrazyl (DPPH) in chloroform and methyl acetate shows that the critical concentration of DPPH (the concentration necessary to capture all the primary radicals) is directly proportional to the maximum local concentration of the radicals. The study of the variation of the critical concentration as a function of the radiation intensity permits the characterization of two thresholds of intensity beyond which the concentration is respectively quasi-homogeneous and very heterogeneous. The variation of the critical concentration in the intensity range studied (0.3 to 1.00 r/min) is interpreted with the aid of the Magee and Samuel model. From these simple considerations a factor of homogeneity is defined which represents the relative concentrations of the radicals in the primary groups and in the background at the moment of chemical reaction. The results indicate that x or  $\gamma$  irradiation of a pure liquid leads to a quasi-homogeneous distribution of the free radicals in the stationary state. (tr-auth)

## RADIATION EFFECTS

5182

THE PRIMARY RADICAL YIELD IN IRRADIATED WATER. J. Rowbottom (The Univ., Leeds, England) *Science* 119, 904-5(1954) June 25.

Estimates of the number of water molecules decomposed to form radicals by 100 ev of energy absorbed are discussed. It is postulated that the absorption of ionizing radiation in water gives rise to two groups of radicals, one group being available only to the most reactive of solutes and another group being universally available. Experimental studies supporting this theory are discussed. (C. H.)



5183

THE INACTIVATION OF MONOMOLECULAR FILMS OF PROTEIN AND ITS RELATION TO THE LIFETIME OF ACTIVE RADICALS FORMED IN WATER BY X-RADIATION. C. L. Smith (Yale Univ., New Haven, Connecticut). *Arch. Biochem. and Biophys.* 50, 322-36(1954) June.

The inactivation by x rays of monomolecular layers of catalase and of bovine serum albumin (BSA) in pure air-free water has been studied. No measurable inactivation can be detected with doses of less than about 100,000 r. With doses of 500,000 r the respective inactivations are 48 and 12%. The ionic yields for catalase and BSA in solution have also been measured and the values obtained are 0.044 and 0.023 molecules/ion pair, respectively. From these measurements, the half-life time of the radicals produced in the water by the x radiations, and assumed to be responsible for the inactivation, can be calculated to be between about  $10^{-5}$  and  $10^{-6}$  sec. (auth)

#### RARE EARTHS AND RARE-EARTH COMPOUNDS

5184

THE SEPARATION OF RARE EARTHS BY DISTRIBUTION BETWEEN TWO SOLVENTS. Werner Fischer, G. Braune, W. Dietz, O. Jübermann, Gotthard Krause, K.-E. Niemann, and G. Siekemeyer. *Angew. Chem.* 66, 317-25(1954) June 21.

Separation of rare earths by distribution between two solvents can be carried out by the use of different rare earth compounds and numerous solvents. The basis of the process, the apparatus used, and some examples of preparation separations are described. The separation effect of an individual step has the same order of magnitude as an individual step in the crystal fractionation process. However, solvent extraction is preferable because of the smaller time and work expenditures. (tr-auth)

#### SEPARATION PROCEDURES

5185

Mound Lab.

PRECIPITATION OF BARIUM CARBONATE. Harry Teicher. Dec. 16, 1953. 15p. Contract AT-33-1-GEN-53. (MLM-931)

In the precipitation of barium carbonate it was found that a denser, more filterable and more easily washed product was obtained by bubbling carbon dioxide into an ammoniacal solution than was formed by the usual procedure. The solubility loss of barium carbonate was studied with respect to final pH, alcohol concentration of the wash solution, addition of alcohol to the mixture after precipitation, and the presence of excess ammonium salts. A recommended procedure is described which resulted in a solubility loss of 0.00015 gram of barium in 375 ml of solution. (auth)

5186

THE PROPERTIES OF TITANIUM, NIOBIUM AND TANTALUM COMPOUNDS IN HYDROCHLORIC ACID. A FOUNDATION OF A NEW PREPARATIVE METHOD OF SEPARATION. Josef Wernet. Translated by [Gabriele Wohlaue] from Z. anorg. u. allgem. Chem. 267, 213-37(1952). 30p. (AEC-tr-1932)

An abstract of this paper appears in *Nuclear Science Abstracts* as NSA 6-2344.

5187

SEPARATION OF NIOBIUM AND TANTALUM BY LIQUID-LIQUID EXTRACTION. J. Y. Ellenburg, G. W. Leddicotte, and F. L. Moore (Oak Ridge National Lab., Tenn.). *Anal. Chem.* 26, 1045-7(1954) June.

Studies, using inactive niobium and tantalum as well as radioactive tracers of these elements, indicate that the separation of niobium from tantalum by liquid-liquid

extraction of the hydrochloric acid solution of the elements with long-chain aliphatic and aromatic amines in organic solvents is quantitative. Further studies showed that niobium and tantalum sulfate and oxalate complexes extract with the solvated amines. However, in the case of tribenzylamine in methylene chloride, the niobium sulfate complex may be quantitatively separated from the tantalum sulfate complex if the ratio of organic to aqueous volume is maintained at 15 to 1. These methods should be valuable for rapid separations of these elements and the amine systems may be applied to industrial separations of niobium and tantalum. (auth)

5188

IONIC EQUILIBRIA AND SELF-DIFFUSION RATES IN DESULFONATED CATION EXCHANGERS. G. E. Boyd, B. A. Soldano, and O. D. Bonner (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.* 58, 456-9(1954) June.

Sulfonated polystyrene-divinylbenzene type cation exchangers of variable capacity were prepared by acid hydrolysis at 180 to 220°. Evidence for some rupture of divinylbenzene cross-links was found in an increased moisture absorption. Ionic selectivity coefficients measured for the sodium-hydrogen exchange decreased with decreasing capacity. Complete selectivity reversal at all exchanger compositions (i.e., hydrogen preferred over sodium ion in the exchanger) was found for a 50% desulfonated nominal 16% DVB exchanger. In contrast, the uptake of silver ion in the silver-sodium exchange was increased by decreasing capacity. Self-diffusion coefficients for sodium, silver, zinc, yttrium, and lanthanum ions showed initial increases with lowered exchange capacity, reflecting the breaking of cross-links. At still lower capacities, however, the self-diffusion coefficients decreased and the activation energies increased to large values. (auth)

#### SORPTION PHENOMENA

5189

Georgia Inst. of Tech. Engineering Experiment Station STANDARDIZATION OF SURFACE PROPERTIES OF FINE PARTICLES. QUARTERLY REPORT NO. 2. J. M. Dallavalle, Clyde Orr, Jr., H. G. Blocker, and D. Jane Barrett. Oct. 30, 1953. 28p. Contract DA-36-039-sc-42588. (AD-21860)

This investigation has as its general purpose an evaluation of the surface properties of finely divided solids; its immediate objective is a study of heat of adsorption, i.e., the heat released upon the adsorption of a gas by a solid. Two completely different apparatus utilizing different principles were employed. Heat of adsorption measurements for the adsorption of nitrogen gas on charcoal at rather low temperatures indicated general agreement between the two methods. Heats of adsorption of nitrogen gas on a specially prepared nickel powder at low temperatures were also determined and are believed to be of the correct order of magnitude. A spreading of the experimental data, the source of which is not believed to be entirely experimental error, was evident, however. Additional work will be directed toward eliminating this source of error. (auth)

#### TRACER APPLICATIONS

5190

METHOD OF CHEMICAL AND PHYSICAL MEASUREMENTS BASED ON THE DISTRIBUTION OF RADIOACTIVE DISINTEGRATIONS. A. Hee and P. Keller (Institut de Physique du Globe, Strasbourg, France). *J. chim. phys.* 51, 178-80(1954) Apr. (In French)

The systematic study of the distribution of  $\alpha$  rays caused by the disintegration of a deposit of Ra(E + F)



on a film of Ni showed the existence of current which is established in a fluid at the immediate contact of a moving obstacle. Therefore, the distribution of radioactive disintegrations can be used in kinetic experiments on the electrolytic deposition of radioelements and in the study of the sedimentation of radiocolloids. (tr-auth)

5191

STUDIES IN LOW CONCENTRATION CHEMISTRY. VIII. SOME PROPERTIES OF TRACER YTTRIUM, ANTIMONY AND SILVER IN SOLUTION. George K. Schweitzer and W. Morrison Jackson (Univ. of Tennessee, Knoxville). *J. Am. Chem. Soc.* **76**, 3348-9(1954) June 20. (cf. NSA 8-1820).

Filtration, centrifugation, and adsorption experiments were carried out in an investigation of the radiocolloidal properties of Y, Sb, and Ag in tracer concentrations. The results led to the conclusion that the adsorption of Y upon impurities suspended in solution is probably not the major factor involved in the formation of radiocolloids. The Sb probably existed partly as a radiocolloid and partly as chloro- or chlorohydroxo- complexes at all pH values. The results in the Ag experiments were consistent with true colloid formation and not with adsorption of Ag ions onto suspended impurities. (A.G.W.)

#### TRANSURANIC ELEMENTS AND COMPOUNDS

5192

KINETICS OF REACTIONS BETWEEN NEPTUNIUM IONS. THE NEPTUNIUM(IV)-NEPTUNIUM(VI) REACTION IN PERCHLORATE SOLUTION. J. C. Hindman, J. C. Sullivan, and Donald Cohen (Argonne National Lab., Lemont, Ill.). *J. Am. Chem. Soc.* **76**, 3278-80(1954) June 20.

An investigation of the mechanism of the reaction  $\text{Np(IV)} + \text{Np(VI)} \rightleftharpoons 2\text{Np(V)}$  has been undertaken in perchlorate media. The rate law for the forward reaction is given by:  $-d(\text{Np}^{+4})/dt = k_1^0[\text{Np}^{+4}][\text{NpO}_2^{+2}][\text{H}^+]^{-2}$ . At  $25^\circ$  and  $\mu = 2.00$ ,  $k_1^0$  is  $2.69 \text{ mole/l/min}$ ;  $\Delta H^\ddagger$  is  $24.6 \text{ kcal}$ ;  $\Delta S^\ddagger$  is  $17.8 \text{ cal/deg}$  and  $\Delta F^\ddagger$  is  $19.3 \text{ kcal}$ . At  $25^\circ$  and  $\mu = 1.00$ ,  $k_1^0$  is  $3.13 \text{ mole/l/min}$ . The effect of ionic strength has been measured. Two alternative mechanisms for the reaction are postulated. (auth)

#### TRITIUM AND TRITIUM COMPOUNDS

5193

PERCUTANEOUS ABSORPTION OF TRITIUM OXIDE. Chester W. DeLong, Roy C. Thompson, and Harry A. Kornberg (General Electric Co., Richland, Washington). *Am. J. Roentgenol. Radium Therapy Nuclear Med.* **71**, 1038-45(1954) June.

The percutaneous absorption of tritium oxide-labeled water vapor was studied in mice, rats, and man. In terms of  $\mu\text{g}$  water absorbed/ $\text{cm}^2/\text{min}$  from a saturated water vapor atmosphere, the rates found were: for mice (abdomen),  $20 \pm 5$ ; rats (abdomen),  $5.7 \pm 1.1$ ; man (forearm),  $8.6 \pm 1.7$ . A single total body exposure to a human at 70 per cent relative humidity gave a rate of  $18 \mu\text{g}/\text{cm}^2/\text{min}$ . The rate of water vapor absorption in the rat was found to be directly proportional to water vapor pressure. For a constant level of atmospheric tritium oxide, absorption of tritium oxide was independent of total water vapor pressure. It was shown that for humans the rate of percutaneous absorption of tritium from a tritium oxide-contaminated atmosphere is about the same as the rate of pulmonary absorption from the same atmosphere. (auth)

#### URANIUM AND URANIUM COMPOUNDS

5194

ON THE PAPER CHROMATOGRAPHIC DETERMINATION OF URANIUM. H. Seiler, Margrit Schuster and H. Erlen-

meyer. *Helv. Chem. Acta* **37**, 1252-3(1954) June. (In German)

A qualitative and quantitative paper chromatographic method for the determination of U in rocks is described. (tr-auth)

5195

QUADRIVALENT URANIUM AS A REDUCING TITRANT. Ronald Belcher, Derek Gibbons, and Thomas S. West (Univ. of Birmingham, England). *Anal. Chem.* **26**, 1025-7 (1954) June.

Quadrivalent uranium has a redox potential of  $-0.334 \text{ volt}$  in  $0.1N$  acid solution and is, therefore, a moderate reducing agent. It is fairly stable to atmospheric oxidation. Quadrivalent uranium, as a reducing titrant, is one of the most stable titrants that can be used for the direct titration of ferric iron. Although it can be used for several other titrations, it has no advantages over existing reagents and, in most cases, is less convenient. (auth)

## ENGINEERING

5196

Argonne National Lab.

SUMMARY OF SHAFT SEAL TESTS FOR HIGH-TEMPERATURE, HIGH-PRESSURE WATER APPLICATION. A. Smaardyk. Apr. 1954. 33p. Contract W-31-109-eng-38. (ANL-5220)

A program directed toward the development of an all-metallic seal assembly for use in connection with the design of external control rod drive actuating mechanisms for pressurized, water-cooled reactor systems is summarized. Various material combinations are evaluated based upon performance in seal component assembly tests conducted in dynamic water systems at temperatures up to  $450^\circ\text{F}$  and pressures up to  $2000 \text{ psig}$ . Specifications and drawings of seals are included; test data are presented in tabular and graphical form. (auth)

5197

Knolls Atomic Power Lab.

ANALYSIS OF ANNULAR SHELLS WITH APPLICATIONS TO WELDED BELLOWS. M. Hetenyi and R. J. Timms. [1954] 150p. Contract W-31-109-Eng-52. (KAPL-1089)

A method is presented for the calculation of stresses and deflections in ring-shaped shells of circular cross-section, subjected to axially symmetrical loadings. The solution is derived without the restriction imposed for toroidal shells by previous investigators, that the radius of curvature of the cross section is to be small in comparison with the mean radius of the torus. The range of applicability of the method is extended to include the slightly arched convolutions used in the construction of welded bellows. By a rational reduction of the general solution approximate design formulas are obtained for the maximum stresses and deflections in bellows under axial forces and pressure loadings, and the calculated values are compared with experimental data. (auth)

5198

Thomson Lab., General Electric Co.

ALIGNMENT CHART FOR SLEEVE BEARING COMPUTATIONS. D. F. Wilcox and M. J. Rosenblatt. Mar. 2, 1953. 27p. (R53TL039)

This chart represents a graphical method for calculating cylindrical sleeve bearing performance. This chart in pad form may be used as a permanent record of bearing computations. The usual types of bearing design problems may be solved with its help. The desirability of extending to non-



cylindrical bearings is indicated, and such extension is planned. (auth)

## HEAT TRANSFER AND FLUID FLOW

5199

Lewis Flight Propulsion Lab., NACA  
ANALYSIS OF TURBULENT HEAT TRANSFER, MASS TRANSFER, AND FRICTION IN SMOOTH TUBES AT HIGH PRANDTL AND SCHMIDT NUMBERS. Robert G. Deissler. May 1954. 53p. (NACA-TN-3145)

The expression for eddy diffusivity from a previous analysis was modified in order to account for the effect of kinematic viscosity in reducing the turbulence in the region close to a wall. By using the modified expression, good agreement was obtained between predicted and experimental results for heat and mass transfer at Prandtl and Schmidt numbers between 0.5 and 3000. The effects of length-to-diameter ratio and of variable viscosity were also investigated for a wide range of Prandtl numbers. (auth)

5200

Oak Ridge National Lab.  
FORCED CONVECTION HEAT TRANSFER IN THERMAL ENTRANCE REGIONS. PART 3. HEAT TRANSFER TO LIQUID METALS. William B. Harrison. 74p. Contract W-7405-eng-26. (ORNL-915)

The heat transfer to liquid metals in turbulent flow within the thermal entrance region of circular tubes having uniform wall temperature was explored. Since liquid metals are characterized by high thermal conductivity, emphasis has been placed on analytical conduction solutions which neglect the contribution to heat transfer that is made by the eddy motion of a fluid in turbulent flow. Three solutions, which differ only in the postulated velocity distribution of the fluid, have been selected for comparison. The postulated velocity distributions are: (1) uniform, (2) parabolic, and (3) velocity proportional to distance from the channel wall raised to the one-seventh power. Other related entrance region solutions are briefly surveyed. In view of the important role played by the molecular thermal conductivity in heat transfer to liquid metals in a direction normal to a tube wall, the influence of thermal conductivity on heat transfer parallel to a tube wall has been examined. Experimental work performed in connection with this study consisted of taking heat transfer data to mercury and sodium in tubes of  $\frac{1}{16}$  in. and  $\frac{1}{8}$  in. length in combination with diameters of  $\frac{1}{16}$  in. and  $\frac{1}{8}$  in. The mercury heat transfer data for three different test sections compare favorably with the conduction solution for a postulated velocity distribution according to the one-seventh power law. These data were taken over a range of Reynolds modulus from 20,000 to 200,000, and heat transfer coefficients up to 66,300 Btu/hr · ft<sup>2</sup> · °F were achieved. Sodium data were erratic and low when compared with the mercury data or the conduction solutions. In an effort to explain this observation, it has been shown that, if a nonwetted condition existed, the small test section diameter and the high thermal conductivity of sodium would combine to maximize the effects on the heat transfer. An attempt was made to corroborate the hypothesis of non-wetting with an experimental study of interfacial electrical resistance, but the results were inconclusive. (auth)

5201

THERMAL CONDUCTIVITY OF GASES. F. G. Keyes (Massachusetts Inst. of Tech., Cambridge). *Trans. Am. Soc. Mech. Eng.* 76, 809-16(1954) July.

A continuation of earlier reported work in connection with two of the fundamental properties required for understanding and designing heat-transfer equipment is presented. New measurements of heat conductivity are presented along with values for viscosity obtained by correlation of all available data found in the literature. The

simplest substance from the point of view of theory is the monatomic gas. The results of a study of the five rare gases are included. (auth)

5202

THE THERMAL CONDUCTIVITY OF FLUIDS. A. F. Schmidt and B. H. Spurlock, Jr. (Univ. of Colorado, Boulder). *Trans. Am. Soc. Mech. Eng.* 76, 823-30(1954) July.

An apparatus is developed which is capable of measuring the thermal conductivity of gases, vapors, and liquids over a wide range of temperatures. A compensating-type hot-wire apparatus was employed to make absolute thermal-conductivity determinations of various fluids; in particular, air was used to check the agreement of experimental results between previous investigations and the present one. The thermal conductivities of furfural vapor and liquid were measured in order to supplement existing data in the field of heat conduction with results of considerable industrial importance. (auth)

## MINERALOGY, METALLURGY, AND CERAMICS

### CORROSION

5203

Naval Engineering Experiment Station, Annapolis  
TESTING OF VARIOUS MATERIALS IN HIGH TEMPERATURE WATERS. C. J. Lancaster. Nov. 30, 1953. 24p. (EES-040028D)

Results of corrosion tests in high-temperature water are reported for a number of selected materials. The following tests were conducted: dynamic autoclave tests at 350°F on stressed specimens in natural sea water; dynamic tests at 120°F on stressed specimens in natural sea water; stress corrosion tests of Type 347 stainless steel tubes in boiler feedwater solutions; and corrosion effects produced in stainless steel test equipment by chloride solutions at elevated temperatures. (auth)

5204

Naval Engineering Experiment Station, Annapolis  
BASIC INFORMATION ON THE BEARING PROPERTIES OF VARIOUS MATERIALS IN LIQUID METALS. W. J. Greenert and M. R. Gross. July 2, 1954. 23p. (EES-090014B)

The report deals with the operation of aluminum thrust and journal bearings in NaK at ambient temperatures of 80 to 400°F. The thrust bearings, at 75-lb load, showed little wear or deterioration after 11,000 hr of exposure and intermittent operation in contaminated NaK. The journal bearings failed at these conditions under 20-lb load. (auth)

5205

Armour Research Foundation  
CORROSION PREVENTIVE ADDITIVES. E. J. Schwoegler and L. U. Berman. Mar. 1954. 166p. Contract AF 33(038)-9202. (WADC-TR-53-16(pt.2))

The development of new corrosion inhibitors that may supplement or replace petroleum sulfonates was studied. The evaluation study was continued with major emphasis on the type of compounds which previously were shown to be effective inhibitors, and the minimum effective concentration was determined. With certain amine salt inhibitors a study was made to determine the effect of heating at 150°C for three hours on corrosion inhibition. A large number of organic compounds were screened by the use of a galvanic specimen test in order to discover inhibitors that might be



effective for inhibiting corrosion in the bimetallic system, 52100 steel-Muntz metal brass. Conditions of temperature, humidity, etc., were studied to arrive at conditions best suited for screening these compounds. Initial studies were made on the mechanism of corrosion inhibition of 1020 steel. In the elucidation of the mechanism of corrosion inhibition, attempts were made to relate effectiveness to the structural and functional group characteristics of the molecules studied. The compound types studied included morpholine derivatives, aliphatic amines, and amine salts of various carboxylic acids in both AN-O-6a and MIL-L-6085A base oils. Many organic compounds were synthesized to assist in the development of new inhibitors and in the elucidation of the mechanism of corrosion inhibition. These included morpholine and ethylenediamine derivatives, amine salts of mono- and dicarboxylic acids, fatty acid derivatives, and substituted glyoxalides. An infrared study on 2- and 1,2-substituted glyoxalidines was made in an effort to arrive at an effective method of verifying these structures. This was essential since certain glyoxalidines were found to have potential inhibiting properties sufficient to warrant further investigation of this type of compound. (auth)

5206

Virginia Univ.

SURVEY OF LITERATURE ON ANTIOXIDANTS AND ANTICORROSION ADDITIVES FOR LUBRICANTS AT ELEVATED TEMPERATURES. James W. Cole, Jr., Alfred Burger, and Arthur F. Benton. May 1954. 830p. Contract AF 33(038)-22947. (WADC-TR-53-353)

A literature survey is presented on oxidation and corrosion inhibitors in various media at elevated temperatures. Particular attention was given to phenothiazine types of additives and to lubricants of the synthetic-base type. Media, such as rubber, were included where the effects noted might have analogies in synthetic-base lubricants. The literature revealed very few antioxidant or anticorrosion combinations for synthetic-base lubricants at extreme temperatures. The survey covered the period 1916 to June 1952. There were very few significant literature references prior to 1916. (auth)

## GEOLOGY AND MINERALOGY

5207

[Wisconsin Univ.]

THE URANIUM OF THE LAVAS OF LASSEN VOLCANIC NATIONAL PARK, CALIFORNIA. J. A. S. Adams and D. F. Saunders. [1952] 11p. (AECU-2899)

The uranium content of the Lassen volcanics varies by a factor of about four from 0.8 ppm to 3.6 ppm by weight. The thorium probably varies also by about a factor of four. The uranium versus potash curve is essentially linear for the Lassen suite. All major sources of radioactivity,  $K^{40}$ , U, and Th, were three to four times more abundant in the most siliceous lava studied than they were in the least siliceous lava studied. (auth)

5208

Grand Junction Operations Office, AEC

RECONNAISSANCE OF LITTLE WILD HORSE MESA GREEN RIVER DESERT, EMERY COUNTY, UTAH. David N. Hinckley and John H. Volgamore. Mar. 2, 1953. 14p. (RME-43)

Little Wild Horse Mesa was covered by ground reconnaissance to determine the possibilities for uranium production from the Salt Wash member of the Morrison formation. The entire area was prospected with the Halross scintillometer. Ground reconnaissance in virgin country revealed only one anomalous locality, which was mapped in detail. Two anomalous localities discovered by airborne reconnaissance were also closely examined. Uranium mineralization on Little Wild Horse Mesa occurs in a medium- to

coarse-grained cross-bedded sandstone, usually near the middle of the Salt Wash sandstone member of the Morrison formation. Locality "A" has slight possibilities of uranium production and warrants no further attention. Locality "B", though not large in extent and not suitably located for drilling, may produce a minor amount of uranium. Locality "C" contains uranium ore of shipping grade in scattered deposits of small size. (auth)

5209

Columbia Univ.

ANNUAL REPORT FOR JUNE 30, 1953 TO APRIL 1, 1954.

PART 1. Paul F. Kerr, Davis M. Lapham, Marc W. Bodine, Jr., P. K. Hamilton, and Philip M. Bethke. Apr. 1954. 83p. Contract AT(30-1)-702. (RME-3096(pt.1))

The work for the period included studies of a nodule from Temple Mountain, Utah, mineralogy of the Carille deposit in Crook Co., Wyo., the properties of uranophane,  $\beta$ -uranotile, and phosphuranylite at Marysvale, Utah, pitchblende and manganocalcite as the principal radioactive minerals in Deer Trail mine, quartz crystals from the Todilto limestone at Grants, N. Mex., occurrence of U in the older sedimentary rocks of the Marysvale district, and x-ray methods applied to the study of tiemannite-metacinnabar group. (J.E.D.)

5210

Statistical Lab., Iowa State Coll.

ANNUAL REPORT [FOR] APRIL 1, 1953 TO MARCH 31, 1954. M. R. Mickey, Jr. and H. W. Jespersen, Jr. Apr. 1954. 65p. Contract AT(30-1)-1377. (RME-3099)

The material discussed falls into three parts. The first deals with pattern drilling as an exploration technique. A basis for the comparison and selection of drilling patterns is presented and the details involved in pattern selection are presented. Secondly, a basis for considering the question of whether a set of observable characteristics is associated with the presence of mineralization is presented. The ideas presented here are further elaborated by application to analysis of data from the Polar Mesa and the Lukachukai Mesa V drilling projects. (For preceding report in series see RME-3056.) (auth)

5211

Division of Raw Materials, AEC

BIBLIOGRAPHY AND INDEX OF LITERATURE ON URANIUM AND THORIUM AND RADIOACTIVE OCCURRENCES IN THE UNITED STATES. PART 4. ARKANSAS, IOWA, KANSAS, LOUISIANA, MINNESOTA, MISSOURI, NEBRASKA, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, AND TEXAS. Margaret Cooper. May 1954. 170p. (RME-4013)

The bibliography consists of references to published literature, press releases, speeches, and both open-file and other unclassified reports dealing with uranium, thorium, and radioactive occurrences in Arkansas, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas. It is Part 4 of a comprehensive bibliography planned to cover references to all similar deposits throughout the world. While the object has been to make the present bibliography as all-inclusive as possible, from the point of view of including all the major papers and at least one reference to each known radioactive occurrence in these eleven states, only references for which the original text was readily available for examination and checking have been cited at this time. (auth)

5212

THE FLUORAPATITE SYSTEM OF EQUILIBRIA IN THE CONDITIONS OF FORMATION OF SEDIMENTARY ROCKS.

A. V. Kazakov. Translated by V. L. Skitsky from *Trudy Inst. Geol. Nauk, Akad. Nauk S.S.S.R.* No. 114, *Geol. Ser.* No. 40, 1-21(1950). 31p. (TEI-385)

As part of unified research on the behavior of the fluoride ion in sedimentary rocks, the present study deals with the



system  $\text{CaO-P}_2\text{O}_5\text{-HF-H}_2\text{O}$  at  $25^\circ\text{C}$ , under conditions of sea sedimentation. The precipitated phases, their fields of crystallization and stability, the fluorine-phosphorus coefficient, and the isomorphism of fluorhydroxyl ions in the apatite lattice are considered and illustrated by orthogonal projections. The results lead to conclusions on fluorapatite sedimentation on phosphate shelves, with its consequent fixation of fluorine, expressed in the form of an average annual balance sheet for the processes involved. (V.L.S.)

5213

# CONDITIONS OF THE FORMATION OF FLUORITE IN SEDIMENTARY ROCKS. (THE FLUORITE SYSTEM).

A. V. Kazakov and E. I. Sokolova. Translated by V. L. Skitsky from *Trudy Inst. Geol. Nauk, Akad. Nauk S.S.S.R.* No. 114, *Geol. Ser.* No. 40, 22-64(1950). 76p. (TEI-386)

The formation of fluorite in sedimentary rocks has been investigated by studies of fluorite equilibria in different solutions. Determinations at different temperatures were made on the solubility of crystalline  $\text{CaF}_2$  in chemically pure water, in aqueous solutions of components of sea water— $\text{CaSO}_4$ ,  $\text{NaCl}$ ,  $\text{Na}_2\text{SO}_4$ , and  $\text{MgSO}_4$ —at different concentrations, and in the sea water itself at degrees of salinity varying from normal to a 15-fold concentration. Conclusions are reached on the effects of the various salts and on the consequent possibilities of fluorite precipitation in basins of different types. Facies conditions of fluorapatite and fluorite deposition are derived for successive states of evaporation of saline basins, and the use of the fluorine-phosphorus coefficient as a facies index is suggested. Literature is reviewed. (V.L.S.)

5214

# GEOLOGICAL SURVEY GEOLOGIC INVESTIGATIONS OF RADIOACTIVE DEPOSITS. SEMIANNUAL PROGRESS REPORT [FOR] DECEMBER 1, 1953 TO MAY 31, 1954. June 1954. 247p. (TEI-440)

A general survey is presented of the program of geologic studies in the U. S. The work consisted of a search for and geology of U in sandstone type deposits, veins, igneous and carbonaceous rocks, and in phosphate deposits. (For preceding period see TEI-390.) (J.E.D.)

5215

# URANOPHANE AT SILVER CLIFF MINE, LUSK, WYOMING. Verl R. Wilmarth and D. H. Johnson. U. S. Geol. Survey Bull. 1009-A, 1954. 12p.

The uranium deposit at the Silver Cliff mine near Lusk, Wyo., consists primarily of uranophane which occurs as fracture fillings and small replacement pockets in faulted and fractured calcareous sandstone of Cambrian (?) age. The country rock in the vicinity of the mine is schist of pre-Cambrian age intruded by pegmatite dikes and is unconformably overlain by almost horizontal sandstone of Cambrian (?) age. The mine is on the southern end of the Lusk Dome, a local structure probably related to the Hartville uplift. In the immediate vicinity of the mine, the dome is cut by the Silver Cliff fault, a north-trending high-trending high-angle reverse fault about 1,200 ft in length with a stratigraphic throw of 70 ft. Uranophane, metatorbernite, pitchblende, calcite, native silver, native copper, chalcocite, azurite, malachite, chrysocolla, and cuprite have been deposited in fractured sandstone. The fault was probably mineralized throughout its length, but because of erosion, the mineralized zone is discontinuous. The principal ore body is about 800 ft long. The width and depth of the mineralized zone are not accurately known but are at least 20 ft and 60 ft respectively. The uranium content of material sampled in the mine ranges from 0.001 to 0.23% uranium, whereas dump samples range from 0.076 to 3.39% uranium. (auth)

5216

# STUDIES OF RADIOACTIVE COMPOUNDS. VII. PHOS-

PHURANYLITE AND DEWINDTITE. D. D. Hogarth (Geological Survey of Canada, Ottawa) and E. W. Nuffield (Univ. of Toronto, Canada). *Am. Mineralogist* 39, 444-7 (1954) May-June. (cf. NSA 5-5689 and 7-4068).

Phosphuranylite from Urgeirica, Portugal, is orthorhombic, Bmmb with a 15.85, b 17.42, c 13.76 Å. Dewindtite from Kasolo, Belgian Congo, is isostructural as shown by Frondel (1950), with a 16.00, b 17.62, c 13.66 Å. Calculations of unit cell contents do not lead to unique chemical formulas for the minerals. Available chemical analyses suggest that the chemical formulas of phosphuranylite and dewindtite are not analogous. (auth)

5217

# STUDIES OF URANIUM MINERALS. XIV. RENARDITE. Clifford Frondel and Frank Cuttitta (Harvard Univ., Cambridge, Mass.). *Am. Mineralogist* 39, 448-51(1954) May-June. (cf. NSA 4-3451, 5-1027, 6-788, and 6-789).

A new chemical analysis of renardite for Katanga has confirmed the formula  $\text{Pb}(\text{UO}_2)_4(\text{PO}_4)_2(\text{OH})_4 \cdot 7\text{H}_2\text{O}$ . X-ray single-crystal study established the unit cell as orthorhombic, with the dimensions a 16.01 Å, b 17.5, c 13.7. Renardite is isostructural with both dewindtite (a 16.07 Å, b 17.50, c 13.62) and phosphuranylite. The chemical composition of dewindtite, however, cannot be reconciled with that of renardite on this basis. Phosphuranylite probably is the calcium analogue of renardite, with the formula  $\text{Ca}(\text{UO}_2)_4(\text{PO}_4)_2(\text{OH})_4 \cdot 7\text{H}_2\text{O}$ . (auth)

# METALS AND METALLURGY

5218

Ames Lab.  
MAGNESIUM-URANIUM ALLOY SYSTEM. George A. Tracy, P. Chiotti, and H. A. Wilhelm. June 1953. Decl. with deletions July 16, 1954. 54p. Contract W-7405-eng-82. (AEC-3635; ISC-377)

Analytical, x-ray, thermal, and metallographic data have been obtained in the study of the magnesium-uranium system, and a proposed phase diagram has been constructed. Almost complete liquid immiscibility was found at temperatures up to  $1255^\circ\text{C}$ , and the compositions of the two liquids which coexist under a pressure of about 3 atmospheres at about  $1150^\circ\text{C}$  are approximately 0.16% by weight uranium in magnesium and 0.004% magnesium in uranium. The solubility of uranium in magnesium decreases to nearly 0.05% at  $675^\circ\text{C}$  and to about 0.0005% at  $650^\circ\text{C}$ . It was found that uranium has little or no effect on the melting point of magnesium. The magnesium does not affect the uranium transformation temperatures sufficiently for detection by the methods employed. Evidence was introduced to show that the previously reported intermediate phases in the magnesium-uranium system were caused by impurities introduced by the crucibles used or possibly by some other source. X-ray data showed that the diffusion bands formed at the uranium-magnesium interface when uranium was heated in contact with magnesium contained in a graphite crucible are composed of uranium monocarbide and uranium dicarbide. X-ray-diffraction patterns also showed the presence of  $\text{U}_2\text{Si}_3$  and  $\text{USi}$  in uranium heated in contact with magnesium contained in a Magnorite crucible which contained a percentage of silicon as an impurity. Methods and apparatus which are suitable for the preparation of alloys of reactive metals under an inert atmosphere are discussed. A heating chamber which was used to prepare alloys under pressures of 3 to 4 atmospheres is shown. Crucibles made of several ceramic materials were found to be reactive or porous toward uranium and magnesium. Crucibles made from high purity magnesium oxide containing 10% by weight of added magnesium fluoride were found to be nonporous and nonreactive toward magnesium-uranium melts. (auth)



5219

Minerals Research Lab., Inst. of Engineering Research, Univ. of Calif., Berkeley  
RELATIONSHIP BETWEEN SMALL ANGLE DISLOCATION BOUNDARIES AND CREEP. B. Ancker, T. H. Hazlett, and E. R. Parker. June 1954. 29p. Contract AT-11-1-Gen-10, Project 1, Technical Report No. 15. (AECU-2919)

Results are reported in studies of the relationship between small-angle boundary density, the creep strength, and room-temperature tensile properties before and after creep in high-purity Ni. It was concluded that the creep rate is a function of the initial quantity of small angle boundaries per grain, and the substructure produced by creep contains a multitude of very small angle boundaries as well as some larger ones of the type developed by cold-work and recovery. These very small angle boundaries are generally parallel and of small extent. Cold-work and recovery produces a different substructure free from a multitude of minute parallel subboundaries. Calculations indicate that the unique part of the substructure developed during high temperature deformation is due to the climbing of dislocations originally piled up at barriers to slip. (C.H.)

5220

Argonne National Lab.  
A STUDY OF THE CRITICAL STRAIN OF ZIRCONIUM. FINAL REPORT. Howard J. Luetzow. Mar. 3, 1953. 53p. Contract W-31-109-eng-38. (ANL-5164)

A study has been made of the critical strain characteristics of zirconium metal from three sources: (a) Bureau of Mines, (b) Foote Mineral Company, and (c) Westinghouse. A critical strain of  $2\% \pm 0.5\%$  elongation was found for the Bureau of Mines material after a two-hour anneal at  $800^\circ\text{C}$ ;  $1.2\% \pm 0.5\%$  elongation after a 48-hour anneal at  $800^\circ\text{C}$ . For the Foote Mineral Company zirconium, a critical strain of 0.3 to 0.7% elongation was found after a two-hour anneal at  $800^\circ\text{C}$ . The purer Westinghouse zirconium did not yield a value for the critical strain under the conditions of the investigation. (auth)

5221

Purdue Univ.  
THE DESIGN OF APPARATUS FOR MEASURING THE CREEP OF GERMANIUM. Richard Arthur Pizarro. May 1954. 52p. Contract AT(11-1)-125. (COO-191)

A machine was designed and built to measure the plastic deformation of a germanium bar heated to  $450^\circ\text{C}$  and loaded as a cantilever beam. Details which are described include tapering of the specimen and location of the load to give a uniform outer-fiber stress, construction of grips compensated for thermal expansion, and the cam used to release the load after the specimen reaches temperature. The cantilever beam assembly fits in a Vycor tube which may be inserted in an electric furnace. The temperature of a point on the specimen did not vary more than  $\pm 4^\circ\text{C}$  during a run, and the temperature at points on the specimen agreed within  $\pm 4^\circ\text{C}$ . Helium was passed through the tube during a run to provide a protective atmosphere. Curves are given which show the deformation of single crystals at calculated outer-fiber stresses of 6870 and 7830 psi. The results are compared with those of Gallagher. The creep curves show three regions, as is customary in creep curves of other materials. The following physical constants were obtained in the course of the design work: the compressive strength of germanium is at least 78,000 psi ( $55 \text{ kg/mm}^2$ ), the tensile strength is about 10,000 psi ( $7.0 \text{ kg/mm}^2$ ), the coefficient of thermal expansion was measured between 20 and  $600^\circ\text{C}$ , and the average thermal expansion coefficient is  $5.9 \times 10^{-6}/^\circ\text{C}$ . (auth)

5222

Ames Lab.  
FURTHER STUDY OF SINTERING PHENOMENA. D. R.

Wilder and E. S. Fitzsimmons. [May 26, 1954]. 29p. Contract [W-7405-eng-82]. (ISC-488)

The sintering mechanism of aluminum oxide was studied with attention to the influence of time, temperature, and particle size. Mechanisms proposed by other investigators are reviewed as they pertain to the information obtained from the study. Shrinkage, density, and grain growth are considered. The rate and degree of sintering increase with decreasing particle size. Loose powders are shown to exhibit sintering phenomena when the particle size is small. (auth)

5223

Ames Lab.  
THE VANADIUM-ZIRCONIUM ALLOY SYSTEM. J. T. Williams. June 15, 1954. 32p. Contract W-7405-eng-82. (ISC-491)

The equilibria in the vanadium-zirconium alloy system were investigated by solidus temperature determinations, thermal analysis, dilatometry, electrical resistance measurements, microscopic examination, and x-ray-diffraction analysis. There is a eutectic reaction at  $1230^\circ\text{C}$  between a compound,  $\text{V}_2\text{Zr}$ , and a solid solution containing 10% vanadium in beta zirconium.  $\text{V}_2\text{Zr}$  decomposes at  $1300^\circ\text{C}$  into liquid and a solid solution containing about 10% zirconium in vanadium. The eutectic composition is probably about 30% vanadium. A eutectoid reaction between  $\text{V}_2\text{Zr}$  and alpha zirconium takes place at  $777^\circ\text{C}$  at a very high rate. The eutectoid composition is 5 wt. % vanadium. The limit of solubility of zirconium in vanadium was estimated to be 5% at  $600^\circ\text{C}$ . (auth)

5224

Columbia Univ.  
THE EFFECT OF PRESSURE ON THE ELECTRODEPOSITION OF METALS. FINAL REPORT. Henry B. Linford and Irving Moch, Jr. May 15, 1954. 145p. Contract DA-30-069-ORD-750. (NP-5230; CU-9-54-ORD-750-ChE)

5225

Carnegie Inst. of Tech.  
PREFERRED ORIENTATION EFFECTS OF MAGNETIC FIELDS AND TEMPERATURE IN AN IRON COBALT ALLOY. Baldwin Sawyer. June 1952. 85p. Contract AT(30-1)-Gen-359. (NYO-3492)

A magnetic field was used as an external influence to introduce a deviation from the normal recrystallization process of a magnetic alloy. The nature of the change induced in the Fe-Co alloy studied, as measured in the final texture, was an increase in those texture components having [100] directions parallel to the field, and a decrease in those components having [110] directions parallel to the field. The effect on [111] directions could not be determined, none of these directions occurring in the planes of the samples. The greatest measured effect was a change in the ratio of two symmetric components from 1:1 to 3:2. These effects could be predicted from the known room temperature anisotropy of magnetic energy of the alloy, if one assumes that the anisotropy does not change sign between room temperature and  $700^\circ\text{C}$ , and is of the same order of magnitude. A secondary magnetostriction effect might also contribute to the explanation. Evidence was obtained indicating grain growth, not nucleation, to be the important phase of the recrystallization process in the determination of the final texture. Thermal effects on final orientation texture were also studied. The ratio of changed to unchanged texture, measured after the recrystallization process, was found to be highly sensitive to the temperature cycle used. Increasing recrystallization temperature increased the amounts of changed structure. Slow heating or a low temperature pretreatment decreased it. An attempt was made to interpret thermal texture effects in terms of activation energies, and rough numerical values were obtained. All of



these observed magnetic and thermal texture effects fit nicely the recent theories of recrystallization textures suggested by Beck and Cahn, using the mechanisms of polygonization and preferential grain growth governed by angular relationships with the matrix. (auth)

5225

General Electric Research Lab.

FUNDAMENTAL RESEARCH IN PHYSICAL METALLURGY. TWENTY-SECOND QUARTERLY REPORT. (PROGRESS REPORT NO. 39). J. H. Hollomon and D. Turnbull. July 5, 1954. 10p. Contract W-31-109-Eng-52. (SO-2034; RL-1123)

The thermodynamic activities of liquid Cu-Au alloys were determined. The low-temperature thermodynamics of the Au-Ni alloy are discussed. The low-temperature specific heat and anisotropy of high-purity graphite, vacuum-sealed in a Cu calorimeter, were determined. The heat capacity of W between 15 and 90°K was measured. (For preceding period see SO-2033.) (J.A.G.)

5227

Radiation Lab., Univ. of Calif., Berkeley

THE BEHAVIOR OF ELECTRODE MATERIALS SUBJECTED TO ENERGY HIGH VACUUM R. F. SPARKING IN THE MEGAVOLT RANGE. Warren W. Chupp, Harry G. Heard, and Eugene J. Lauer. Jan. 14, 1954. Decl. Mar. 3, 1954. 35p. Contract W-7405-eng-48. (UCRL-2099(rev.))

Sparking characteristics for fourteen metals have been obtained in an oil pumped high vacuum cavity at  $10^{-6}$  mm Hg. Voltages up to 1.3 megavolts were generated across the test gap at the resonant frequency of 14 Mc. The geometry was that of a hemispherically-capped cylinder between two parallel planes. A magnetic field of 8000 gauss was applied approximately normal to the planes. The energy storage in the cavity was approximately 10 joules. Sparking rates were measured as a function of gap voltage. Metals are compared as regards voltage holding ability by listing the gap voltage corresponding to the same sparking rate for each metal. Incalloy and 310 stainless steel held the most voltage. The coppers, duraluminum, and silver held the least. Qualitative estimates of spark damage are made. The effects of varying several parameters are discussed. (auth)

5228

Radiation Lab., Univ. of Calif., Berkeley

PREPARATION OF METALLIC TITANIUM BY FILM BOILING (thesis). Alfred William Petersen. Apr. 1954. 55p. Contract W-7405-eng-48. (UCRL-2523)

5229

Battelle Memorial Inst.

THE DEVELOPMENT OF CHROMIUM-BASE HEAT-RESISTANT ALLOYS. J. M. Blocher, Jr., I. E. Campbell, D. J. Maykuth, R. I. Jaffee, and H. B. Goodwin. Jan. 1954. 157p. Contract AF 33(616)-48. (WADC-TR-53-470)

A study was made of the mechanical properties of high-purity chromium prepared by the thermal decomposition of chromous iodide. Modification and development of the conventional iodide-decomposition process led to the preparation of chromium containing less than 150 ppm of total impurities. Analytical techniques were also developed to permit a more realistic evaluation of the purity of chromium than had been available heretofore. Hardness was shown to be a poor criterion of the purity of as-deposited iodide chromium. A rough correlation of as-deposited hardness with total metallic-impurity content was obtained with shows a minimum hardness in the range of 500 to 1000 ppm. An explanation for this phenomenon is offered. Chromium sheet, suitable for testing in bending, was made by arc melting iodide chromium and rolling the resultant ingots at 700°C. Rolling in air without sheathing or other special precautions produced sound sheet, free of cracks. Many samples showed

bend ductility at -25°C. However, brittle failure occurred in all room-temperature tensile tests. This was attributed to minute surface irregularities, derived in grinding, which led to brittle fracture. Additions of controlled amounts of various impurities were made to determine some of the compositional factors affecting the room-temperature ductility of chromium. The elements most detrimental were nickel (above 0.2%), carbon, and sulfur (each in quantities over 0.015%). Iron and silicon are not especially harmful in quantities up to about 0.2%. Variations in oxygen content from about 60 to 3000 ppm had no effect on the bend ductility. Although several lots of chromium containing 5 and 10 ppm of oxygen were prepared, it was not possible (without carbon additions, themselves deleterious) to obtain sheet for bend testing with less than 60 ppm of oxygen. It is quite possible that a sharp increase in ductility occurs at a lower oxygen concentration, as is the case for molybdenum. Nitrogen, like oxygen, had little effect on the bend ductility in quantities above the lowest attained (10 ppm). (auth)

5230

New York Univ. Coll. of Engineering

TITANIUM PHASE DIAGRAM STUDY. FINAL REPORT. Harold Margolin, John P. Nielsen, and Harold K. Work. Apr. 15, 1954. 176p. Contract DA-30-069-ORD-208. (WAL-401/85-31)

An investigation of the phase relationships in the Ti-rich regions of the systems Pb-Ti, Al-Mo-Ti, Mo-O-Ti, Fe-Mn-Ti, Fe-Mo-Ti, and Mn-O-Ti is reported, and the regions investigated in the systems are tabulated. A reinvestigation of the binary Mn-Ti system in the range from 35 to 60% Mn was undertaken as part of the study of the ternary systems containing Mn. The results of the partial phase diagrams for these systems are reported. (J.E.D.)

5231

ANNEALING OF TITANIUM. E. R. Funk. (Goodyear Aircraft Corp., Akron, Ohio). *Metal Progr.* 66, 103-5 (1954) July 1.

The proper temperature for annealing cold worked Ti sheet was determined by prestraining tensile samples, annealing one hr, and then pulling to fracture. The best annealing temperature (1100°F) gave highest total strain. (auth)

5232

TITANIUM EXTRACTION BY CHLORIDE PROCESS PRESENTS A VARIETY OF PROBLEMS. W. R. Opie (National Lead Co., Titanium Div., South Amboy, N. J.). *J. Metals* 6, 807-10(1954) July.

A study was made of the complex problems which are met in preparing a ductile Ti sponge from its ores. The steps in the extraction of Ti by the chloride process consist of the preparation of a chlorinator feed chlorination to produce  $TiCl_4$ , purification of  $TiCl_4$ , and the reduction to the metal. (J.E.D.)

5233

G-MODULUS TEMPERATURE COEFFICIENT FOR BERYLLIUM COPPER WIRE. John T. Richards (Precision Products, Inc., Reading, Penna.). *J. Metals* 6, 827-8(1954) July.

The G-modulus values were calculated from the load-deflection characteristics of helical compression springs. Tests were limited to low stress ranges to minimize the effects of end coils and changes in pitch angle. Dead-weight loading was applied, while deflection was measured with an electronic micrometer having a sensitivity of 0.00001 in. and an accuracy of 0.000025 in. Springs were mounted in a suitable furnace permitting adequate temperature control over the desired range. The effect of temperature upon the deflection characteristics of Be-Cu springs is plotted. (J.E.D.)



5234

INFLUENCE OF THE REPARTITION OF IMPURITIES ON THE MICROGRAPHIC COMPONENT OF GRAIN BOUNDARIES AND SUB-BOUNDARIES AFTER HEAT TREATMENT, IN THE CASE OF REFINED ALUMINUM. Gérard Wyon and Jean-Mary Marchin. *Compt. rend.* **238**, 2420-2 (1954) June 21. (In French).

The micrographic attack of fluorinated aqua regia yields fine corrosion forms, probably localized to points of dislocation emergence on the surface, if a "dislocation-impurity" association is understood. This explains the modification in appearance of boundaries and sub-boundaries observed after various heat treatments. (tr-auth)

5235

TERNARY METALLIC PHASES IN THE Ta-C-N, Ta-C-O, AND Ta-N-O SYSTEMS. Nils Schönberg (Univ. of Uppsala, Sweden). *Acta Chem. Scand.* **8**, No. 4, 620-3 (1954).

Ta-C-N, Ta-C-O, and Ta-N-O samples with the non-metal/metal ratio  $\leq 1$  have been prepared with different methods. No ternary phase has been found in the Ta-C-N system. Solid solubility ranges have to some extent been determined in this system. At least one metallic phase exists in the Ta-C-O system: a compound with the approximate composition  $Ta_2(C, O)$  has a tetragonally deformed NaCl structure. Four metallic phases with the following approximate compositions have been prepared in the Ta-N-O system:  $TaN_{0.30}O_{0.10}$ ,  $TaN_{0.75}O_{0.25}$ ,  $TaN_{0.65}O_{0.35}$ , and  $TaN_{0.50}O_{0.50}$ . The structure for the nitrogen-richest compound is closely related to that of  $\epsilon$ -Ta<sub>2</sub>N, and the following two oxide-nitrides have  $\delta$ -Ta<sub>2</sub>N superstructures. An outline of the part of the Ta-N-O system with the (N,O)/Ta ratio  $\leq 1$  has been drawn. (auth)

5236

THE COMPOSITION OF THE PHASES IN THE VANADIUM-CARBON SYSTEM. Nils Schönberg (Univ. of Uppsala, Sweden). *Acta Chem. Scand.* **8**, No. 4, 624-6 (1954).

The compositions of the phases in the V-C system have been determined by x-ray methods. The solubility of carbon in vanadium is about 0.2 wt. % (1 at. %) at about 1000°C. The  $V_2C$  phase of the L'3 type is homogeneous between the limits  $VC_{0.37}$  (8.0 wt. % = 27 at. % of C) and  $VC_{0.50}$  (10.5 wt. % = 33 at. % of C). The VC phase of the B1 type is homogeneous between the limits  $VC_{0.75}$  (15.1 wt. % = 43 at. % of C) and  $VC_{0.96}$  (18.5 wt. % = 49 at. % of C). The fact that the formula VC could not be attained may be due to low reaction velocities. (auth)

5237

THE STRUCTURE OF THE METALLIC QUATERNARY PHASE  $ZrTaNO$ . Nils Schönberg (Univ. of Uppsala, Sweden). *Acta Chem. Scand.* **8**, No. 4, 627-9 (1954).

Some sections of the quaternary Zr-Ta-N-O system were investigated by x-ray methods to find whether metallic ternary and quaternary phases exist. A metallic compound  $ZrTaNO$  was prepared. The metal atoms occupy ordered positions in a hexagonal close-packed arrangement. The c/a value is close to unity, differing widely from the ideal value of  $\sqrt{3/2} = 1.63$ . The positions of the nonmetal atoms were discussed. A structure is suggested which is not related to that of metallic compounds of "interstitial" structure types. (auth)

5238

MACHINING RADIOACTIVE MATERIALS. M. Simnad and P. Shewmon (Carnegie Inst. of Tech., Pittsburgh, Penna.) *Nucleonics* **12**, No. 7, 69 (1954) July.

A simple and effective method of machining radioactive metals is described. The sample is placed in the lathe, and its surface is coated with vaseline grease. A small beaker is placed below the sample where it is being cut. The metal removed during the machining sticks to the

vaseline and is collected in the beaker. At the end of the machining the samples are washed with an organic solvent to remove the vaseline, the solution is filtered, and the sample on the filter paper is counted in the usual manner. (L.T.W.)

5239

INVESTIGATION OF THE STRUCTURE AND PROPERTIES OF THE ALLOY Cu-Ni-Fe. D. Balli and M. I. Zakharova (Moscow State Univ. im. M. V. Lomonosov, Russia). *Doklady Akad. Nauk S.S.S.R.* **96**, 737-40 (1954) June 1. (In Russian)

Diffraction studies were made of 10 Cu-Ni-Fe alloys containing 40 to 70% Cu, 10 to 30% Fe, and 20 to 40% Ni. The alloys were prepared by fusion in a vacuum with subsequent homogenization at 950° for 10 hours. The size of the crystal nucleus, the coercive intensity, and the atomic displacement were determined as a function of the annealing time and tabulated. (J.S.R.)

5240

INFLUENCE OF IMPURITIES ON THE HEAT STABILITY OF ALUMINUM. A. A. Bochvar, Z. A. Sviderskaya, and L. M. Kychakova. *Izvest. Akad. Nauk S.S.S.R. Otdel. Tekh. Nauk*, 46-51 (1954) Feb. (In Russian)

The influence of minute amounts of Fe and Si on the heat stability of Al was investigated at room temperatures and 300°. The results showed that small amounts of Fe can cause a significant rise in the heat stability. Si also causes an increase, but a much smaller one. (J.S.R.)

5241

HEAVY ALLOY PRODUCTION. *Metallurgia* **49**, 276-8 (1954) June.

A study was made of heavy alloy of W, prepared by sintered powdered Ni or Ni and Cu to the powdered W, to be used as a protective material for absorbing  $\gamma$  radiation emitted by Ra sources. The method of manufacture and applications are discussed. (J.E.D.)

5242

ELECTRODE POTENTIAL AND CORROSION OF MOLYBDENUM AND TUNGSTEN. A. Ya. Shatalov and I. A. Marshakov. *Zhur. Fiz. Khim.* **28**, 42-50 (1954) Jan. (In Russian)

A systematic measurement of the electrode potential of Mo and W in buffered solutions with different amounts of chloride ion was made. It was shown that the irreversible potential has a linear dependence on the pH and can be expressed by the equations  $E_{Mo} = \begin{vmatrix} 0.35 \\ 0.40 \end{vmatrix} - 0.045 \text{ pH}$  and

$E_W = \begin{vmatrix} 0.28 \\ 0.33 \end{vmatrix} - 0.045 \text{ pH}$ . Mo and W approximate the metallic electrodes with a large shift in the fixed potential to the positive side. W occupies an intermediate position between the potentials of metallic and nonmetallic electrodes. The electrochemical behavior of Mo and W in 20 different electrolytes follows the curve  $E - \lg N$ . The main influence on the potential of Mo and W is exerted by basic solutions. This dependence is caused by the change in the pH of the solution because of hydrolysis or dissociation of the electrolyte, formation of complex ions, or passivation of the surface by the action of oxidizing agents. Quantitative tests were made of the corrosion resistance of Mo and W by gravimetric and volumetric methods. A comparison of the measured corrosion loss with the quantity calculated by the volume of absorbed  $O_2$  shows good agreement between the two if it is assumed the Mo and W are oxidized to  $MoO_3$  and  $WO_3$ . (tr-auth)

5243

INVESTIGATION OF THE STRUCTURAL CHANGES IN IRON-NICKEL-ALUMINUM ALLOYS BY THE METHOD OF HEAT CAPACITY. V. A. Troshkina and K. G.



Khomyakov (Moscow State Univ. im. M. V. Lomonosov, Russia). *Zhur. Obshchei Khim.* **24**, 780-90(1954) May. (In Russian)

The heat capacity was investigated for the following annealed, tempered, and highly coercive alloys: in the  $\beta + \beta'$  range the alloys containing 54.8 at. % Fe, 23.3 at. % Ni, 21.9 at. % Al and 55.7 at. % Fe, 21.0 at. % Ni, 23.3 at. % Al; in the  $\beta'$  range the alloy containing 35.0 at. % Fe, 25.4 at. % Ni, and 39.6 at. % Al. The energetic change is shown by means of the highly coercive condition. Three exothermic conversions were found in the ranges 300 to 450, 450 to 550, and 580 to 650°. It was established that with the process of magnetic hardening of the alloys the conversion is confined to the range 580 to 650°. The limits of the  $\beta + \beta'$  range are not precise enough in the phase diagrams of the Fe-Ni-Al alloy system. The aging range is higher than 550°. Experimental data do not indicate the principal differences between the energetic properties of the highly coercive samples obtained in the process of hardening and annealing and under the conditions of continuous cooling. (J.S.R.)

## PHYSICS

5244

European Council for Nuclear Research  
ETUDE DES CONSTANTES DE TEMPS DES DIFFERENTS CIRCUITS BU MODELE AC III ET DE SON ALIMENTATION. (Study of the Time Constants of Various Circuits of Model AC III and Its Power Supply). J. Andersen, P. Denis, G. Petrucci, L. Resegotti, and A. Sarazin. May 1954. 26p. (CERN/PS/MM/3)

Time constants of the magnetic field of a model magnet for the CERN synchrotron are studied as a function of magnet current. Several circuits for feeding the magnet windings from the power supply are investigated for the purpose of determining their effect on these constants. (K.S.)

5245

European Council for Nuclear Research  
FLUX DE FUITES DE L'AIMANT AC III/1. (Leakage Flux of the Magnet AC III/1). J. Andersen, P. Denis, G. Petrucci, L. Resegotti, and A. Sarazin. May 1954. 10p. (CERN/PS/MM/4)

Leakage fluxes were measured as a function of magnet current, in the median plane, at extremities of a model magnet for the projected CERN synchrotron. Fluxes from the residual field were also measured. (K.S.)

5246

European Council for Nuclear Research  
LA SITUATION MAGNETIQUE EN MAI 1954. (The Status of the Magnet as of May 1954). May 19, 1954. 7p. (CERN/PS/PD/2)

Aspects of the magnet design program for the CERN synchrotron are outlined. Magnet contouring, field distribution and focusing requirements are specifically treated. (K.S.)

5247

Ames Lab.  
PROGRESS REPORT ON FRICTION LOSS OF SLURRIES IN STRAIGHT TUBES. Glenn Murphy, Donald F. Young, and Richard J. Burlan. Apr. 1, 1954. 79p. Contract W-7405-eng-82. (ISC-474)

A summary of the results obtained to date on the experimental evaluation of the loss of head entailed in pumping slurries through a straight horizontal tube is reported. The

slurries used in the investigation consisted of spherical particles of glass, steel, and lead in water. The particle size and concentrations were nominally constant for a given slurry, but the various slurries tested covered the size range from 0.00122 to 0.0722 in. in diameter. Concentrations from zero to approximately 50% by weight were used. Three types of flow were observed, each identified by a characteristic distribution of particles across the tube. The high-velocity region is characterized by a uniform distribution of particles; the transition region, by a non-uniform distribution of particles, but no stationary layer; and the low-velocity region, by a stationary layer of particles on the bottom of the tube. Equations were developed for evaluating the loss in head over a range of velocities. (auth)

5248

Knolls Atomic Power Lab.  
ACTIVATION PROCEDURES FOR PRODUCING MAXIMUM SECONDARY ELECTRON YIELDS ON ELECTRON MULTIPLIER SURFACES. H. E. Soisson. July 23, 1953. 25p. Contract W-31-109-Eng-52. (KAPL-1113)

Secondary-electron yields of 3.6 were obtained for 7000-volt unresolved positive ions and 500-volt electrons using activated 2% Be-Cu alloy surfaces. Clean platinum surfaces and 4% Be-Cu surfaces were also investigated. Observations of various surface activation procedures were made to determine the temperature and oxygen treatment required to give the most stable and highest secondary-electron-producing surfaces for unresolved positive ions and electrons. (auth)

5249

Institute of Optics, Univ. of Rochester  
RECIPROCITY LAW FAILURE IN DESENSITIZED EMULSIONS. Simpei Tutihasi. June 1954. 24p. Contract AF18(600)-688. (OSR-TN-54-154)

The reciprocity law failure of desensitized emulsions has been studied in the range of the moderate and extremely high-density exposures. It is shown that the desensitized emulsion increases its sensitivity in the high-intensity range relative to the non-desensitized, basic emulsion. Two of the three dyes studied have shown two steps of low intensity reciprocity failure; a strong, primary low intensity failure and a weak, secondary failure. Speculations on the mechanisms of these two failures are given. (auth)

5250

STANDARDIZATION OF BETA-EMITTING NUCLIDES. H. H. Seliger and A. Schwebel (National Bureau of Standards, Washington, D. C.). *Nucleonics* **12**, No. 7, 54-63(1954) July.

Results obtained with various standardization procedures at the National Bureau of Standards are compared with measurements made at laboratories in the U. S., Canada, and England to provide more accurate standards. Primary standardization methods included coincidence counting, internal gas counting and,  $4\pi$  counting. Secondary standardization methods included  $2\pi\beta$  ionization chamber,  $4\pi\gamma$  ionization chamber, and formamide counting. These procedures are briefly described. (L.T.W.)

5251

EFFECT OF PRESSURE ON THE OPTICAL ABSORPTION OF THE ACTIVATOR SYSTEM IN KCl:Tl. Peter D. Johnson and Ferd E. Williams (General Electric Research Lab., Schenectady, N. Y.). *Phys. Rev.* **95**, 69-70(1954) July 1.

The optical absorption spectrum of thallium-activated potassium chloride has been measured at 2000 atmospheres. The absorption band corresponding to the  $^3S_0 \rightarrow ^3P_1^0$  transition of  $Tl^+$  shifts 4Å to longer wavelengths at this pressure. The spectral shift is calculated theoretically from the quantitative configuration coordinate model of KCl:Tl. The occupation probabilities of accessible atomic con-

figurations of the activator system are dependent on pressure, whereas the transition energy for a particular configuration is independent of pressure. The pressure is considered to act hydrostatically on six pistons corresponding to the  $\text{Cl}^-$  nearest neighbors. The theoretical shift in absorption under 2000 atmospheres pressure is 5 Å to longer wavelengths. (auth)

5252

RELATIVISTIC THOMAS-FERMI ATOM MODEL. J. J. Gilvarry (The Rand Corp., Santa Monica, Calif.). *Phys. Rev.* **95**, 71-2(1954) July 1.

It is shown that an expression for the density of states derived from the Dirac wave equation for a central field removes the convergence difficulties in the usual relativistic Thomas-Fermi equation. (auth)

5253

THERMAL CONDUCTIVITY OF LIQUID HELIUM BELOW 1.0°K. Henry A. Fairbank and J. Wilks (Clarendon Lab., Oxford, England). *Phys. Rev.* **95**, 277-8(1954) July 1.

5254

EXPERIMENTAL EVIDENCE FOR STRUCTURE IN THE HELIUM II FILM. W. C. Knudsen and J. R. Dillinger (Univ. of Wisconsin, Madison). *Phys. Rev.* **95**, 279-80 (1954) July 1.

5255

USE OF SILICON p-n JUNCTIONS FOR CONVERTING SOLAR ENERGY TO ELECTRICAL ENERGY. R. L. Cummrow (Knolls Atomic Power Lab., Schenectady, N. Y.). *Phys. Rev.* **95**, 561-2(1954) July 15.

Equations previously developed for the efficiency of semiconductor p-n junctions as power converters are extended to include the case of solar energy conversion in a Si junction. A typical calculation gives an efficiency of 17%, and it is noted that a four-fold increase in solar intensity produces an increase of only 1% in the efficiency. (K.S.)

5256

POWER EFFICIENCY FOR THE PHOTOVOLTAIC EFFECT IN A GERMANIUM GROWN JUNCTION. Ralph P. Ruth and James W. Moyer (Knolls Atomic Power Lab., Schenectady, N. Y.). *Phys. Rev.* **95**, 562-4(1954) July 15.

The photovoltaic efficiency of a grown Ge junction delivering to an external load is investigated. The power efficiency as a function of incident intensity increased with intensity in a manner similar to the characteristics of an open-circuit experiment. The load resistance for maximum power remained essentially constant for the lower intensities (200 to 300 ohms), and decreased to 25 ohms for the highest intensity used. Quantum efficiencies of 0.5 electron-hole pairs per absorbed photon were obtained for Ge at peak response. This discrepancy with the accepted value of the photovoltaic efficiency of p-n junctions is attributed to excessive recombination of generated charges at the crystal surface and to an effective series resistance at the electrode contacts. (K.S.)

5257

FERMI-DIRAC DEGENERACY IN LIQUID  $\text{He}^3$  BELOW 1°K. William M. Fairbank, W. B. Ard, and G. K. Walters (Duke Univ., Durham, N. C.). *Phys. Rev.* **95**, 566-8(1954) July 15.

The temperature dependence of the nuclear magnetic susceptibility of liquid  $\text{He}^3$  has been measured down to 0.23°K by observing the nuclear magnetic resonance absorption signal. The results below 2.1°K give a curve which lies between a classical Curie curve and that for an ideal Fermi-Dirac gas with a degeneracy temperature of 5°K. An arbitrary best fit to the data is a Fermi-Dirac gas with degeneracy at 0.45°K. A possible 4% deviation from the Curie law is indicated at 1.2°K, however this

incipient degeneracy is not outside possible experimental error. (K.S.)

5258

SIMPLE METHOD FOR THE PREPARATION OF UNIFORM RADIOACTIVE SOURCES. G. Charnak and M. Chemla (College of France, Paris) *J. phys. radium* **15**, 490-1 (1954) June. (In French)

Thin uniform radioactive sources can be prepared by sublimation of the radioactive salt. A drop of the salt solution is placed on a platinum sheet and evaporated to dryness. The source support is then placed above the salt, and the underside of the Pt is heated to red heat for a fraction of a second. The salt sublimes from the Pt and is deposited in a uniform layer on the support. (J.S.R.)

5259

ON THE BOSE-EINSTEIN LIQUID MODEL FOR LIQUID HELIUM. III. FURTHER CONSIDERATIONS REGARDING VAPOUR PRESSURES OF  $\text{He}^3$ - $\text{He}^4$  MIXTURES. Ziro Mikura (Tohoku Univ., Sendai, Japan). *Progr. Theoret. Phys. (Japan)* **11**, 244-50(1954) March.

5260

DETERMINATION OF THE MASS OF PARTICLES STOPPED IN NUCLEAR EMULSIONS BY MEASURING THE MULTIPLE DIFFUSION. Agnès Orkin-Lecourtois. *Compt. rend.* **238**, 2311-13(1954) June 14. (In French)

The mass of a particle with unit charge which is stopped in a nuclear emulsion can be determined by the method of "constant deflection." This method compensates for the variation in the path of the average deflection in multiple diffusion by a variation corresponding to the call of measurements. The average value of the mass found for 3 $\tau$  mesons was  $1010 \pm 135 m_e$ . (J.S.R.)

5261

THE MAGNETIC PROPERTIES OF THE ELEMENTS NIOBIUM, TANTALUM, AND RHENIUM. STUDIES IN MAGNETOCHEMISTRY. II. R. W. Asmussen and H. Soling (Technical Univ. of Denmark, Copenhagen). *Acta Chem. Scand.* **8**, No. 4, 563-8(1954).

The magnetic susceptibilities of niobium, tantalum, and rhenium have been measured at varying temperatures (79 to 578°K) and at different values of field strength at each temperature. These metals exhibit feeble paramagnetic susceptibilities, which are nearly temperature independent. The  $\chi_g, T$  curves for niobium and tantalum show that  $\chi_g$  decreases slowly and linearly with increasing temperature, the temperature coefficients being  $-0.0003$ , and  $-0.00006$ , respectively. The  $\chi_g, T$  curve for rhenium increases extremely slowly and linearly with the temperature (interpreted as temperature independence). All susceptibilities measured are field strength independent at all the temperatures investigated. As average values for the atomic magnetic susceptibilities for niobium, tantalum, and rhenium in the temperature interval 79 to 578°K may be accepted the values:  $+207 \times 10^{-6}$ ,  $+151 \times 10^{-6}$ , and  $+56 \times 10^{-6}$ , respectively. (auth)

5262

SECONDARY EMISSION FROM NICHROME V, CuBe, AND AgMg ALLOY TARGETS DUE TO POSITIVE ION BOMBARDMENT. Michael J. Higatsberger, H. L. Demorest, and Alfred O. Nier (Univ. of Minnesota, Minneapolis). *J. Appl. Phys.* **25**, 883-6(1954) July.

A mass spectrometer ion collector system has been devised for the investigation of secondary electron emission by impact of ions on surfaces. Results are reported for various ions incident on clean, baked (but not atomically clean) surfaces of AgMg, CuBe, and Nichrome V targets. For rare gas isotopic ions it is found that for a given energy ion the value of  $\gamma$  varies approximately inversely with the square root of the mass. (auth)



5263

**SHADOWING TECHNIQUE FOR ELECTRON MICROSCOPY—A POSSIBLE SUBSTITUTE FOR THE HIGH-VACUUM EVAPORATION TECHNIQUE.** Alvin E. Bills and Robert Lefker (Signal Corps Engineering Labs., Fort Monmouth, N. J.). *J. Appl. Phys.* 25, 901-3(1954) July.

A method of shadowing samples directly within the electron microscope has been developed. This method, which used thallium chloride immersed in distilled water as the shadowing material, is much less time consuming than is the usual method that involves high-vacuum metal evaporation; the results obtained are not of the same high quality as those of the usual method, but the time saving often justifies the method. Polystyrene Latex (batch No. 580) is introduced on the specimen screen, to provide an internal calibration standard; this standard makes it possible to measure the angle of shadowing. (auth)

## AEROSOLS

5264

Clarkson Coll. of Tech.

**THE SIZE AND SHAPE OF COLLOIDAL PARTICLES BY LIGHT SCATTERING. TECHNICAL REPORT NO. 1. SCATTERING FUNCTIONS FOR SPHERICAL PARTICLES OF REFRACTIVE INDEX 1.46–4.30.** Milton Kerker. Oct. 13, 1953. 72p. Contract DA-30-115-ORD-309. (AD-26048)

Scattering functions were computed for the range of refractive indices and particle sizes encountered in an experimental study of light scattering by Hg aerosols. (C.H.)

5265

**Air Cleaning Lab., Harvard Univ. School of Public Health PERFORMANCE OF THE MODEL K ELECTRO-POLAR FILTER.** (Report of Laboratory Tests). Charles E. Billings, Richard Dennis, and Leslie Silverman. July 15, 1954. 30p. Contract AT(30-1)-841. (NYO-1592)

Results of performance tests are presented for the Model K Electro-Polar Filter, a high efficiency, low-loading dust collector developed by the Western Precipitation Corporation. Collecting mechanisms in this device combine the filtration characteristics of fine Fiberglas mats with the electrostatic effects produced by placing the mats between a positively charged (15 kv) screen and a grounded screen. (auth)

## COSMIC RADIATION

5266

**MESON SHOWERS AND HIGH-ENERGY INTERACTIONS IN LIGHT AND HEAVY NUCLEI.** R. W. Parsons, Françoise A. Brisbout, and V. C. Hopper (Univ. of Melbourne, Australia). *Phys. Rev.* 95, 193-7(1954) July 1.

A study has been made of nuclear disintegrations produced in electron-sensitive emulsions exposed to cosmic radiation at 80,000 ft. Of 93 stars containing more than three shower particles, 29 were interpreted as being induced in the light nuclei C, N, O, and 64 in the heavy nuclei Ag and Br. The low-energy tracks appear to be emitted isotropically from a slowly moving nucleus and the forward collimation of the remaining tracks is discussed. The average numbers of shower particles from the heavy and light nuclei are 7.7 and 6.4<sub>5</sub>, respectively, and it is shown that these figures are consistent with multiple processes of meson production. The difference between the angular distributions of shower particles from heavy and light nuclei is discussed on the assumption that it is mainly due to scattering. (auth)

5267

**THEORY OF UNSTABLE HEAVY PARTICLES.** Hiroshi Enatsu (Columbia Univ., New York), Hiroichi Hasegawa, and Pong Yui Pac (Kyoto Univ., Japan). *Phys. Rev.* 95, 263-70(1954) July 1.

In order to explain the nature of unstable heavy particles which are found in the penetrating components of cosmic rays, a possible model is presented. A mass relation for elementary particles is derived from the conditions for the elimination of divergences of the nucleon and heavy-nucleon self energies. By choosing a suitable set of interactions, the lifetimes of these particles are calculated. Their production is evaluated, and their contribution to the magnetic moments of nucleons is also discussed. It is found that the predictions of the present theory are not qualitatively at variance with experimental results. (auth)

5268

**CORE STRUCTURE IN SOFT COMPONENT SHOWERS.**

H. S. Green and O. Bergmann (Univ. of Adelaide, Australia). *Phys. Rev.* 95, 516-21(1954) July 15.

Methods are devised for the solution of the integro-differential equations for the evolution and spread of the soft component of the cosmic radiation, avoiding approximations made in earlier work. The behavior of the radial and angular distribution functions is analyzed near their origins and coefficients are found in each case for the  $\delta$ -type singularity arising from particles, which together with their ancestors have suffered no Coulomb scattering. In the case of the radial-distribution function for electrons only, there are additional  $r^{-1}$  and  $\log r$  singularities. The contribution of these singularities is compared with that of the over-all distribution by rough numerical computations. Expressions are given for the over-all distribution functions that are suitable for machine computations. (auth)

5269

**IONIZATION CHAMBER MEASUREMENTS AT 10 600 FEET OF THE ABSORPTION OF THE N COMPONENT IN CARBON AND HYDROCARBON.** Robert H. Rediker (Massachusetts Inst. of Tech., Cambridge). *Phys. Rev.* 95, 526-31(1954) July 15.

A detector consisting of a lead-shielded ionization chamber with Geiger counters above and below the chamber is described. The charged N component of energy of several tens of Bev is detected. The absorption of the charged N component in carbon is much smaller than that predicted from the absorption in air. This phenomenon may be explained by the fact that  $\pi$  mesons or other unstable particles which are produced in nuclear interaction can give rise to further nuclear interactions.

Approximate values for the interaction mean free path of N rays in carbon have been obtained. These values depend on the number of shielded counters below the ionization chamber which are struck. For zero counters discharged, the mean free path is  $136 \pm 12$  g/cm<sup>2</sup> and seems to decrease as the requirement on the number of shielded counters struck is increased. The interaction mean free paths in carbon are compared to previous results in lead. The absorption of the N component in oil indicates a cross section of the hydrogen nucleus much smaller than that corresponding to the range of nuclear forces. Events with large pulses from the ionization chamber or with multiple discharge of shielded counters below the chamber are more likely to be associated with the nucleonic component of extensive air showers. (auth)

5270

**COSMIC RADIATION AT VERY HIGH ALTITUDES NEAR THE GEOMAGNETIC EQUATOR.** Martin A. Pomerantz (Bartol Research Foundation, Swarthmore, Penna.). *Phys. Rev.* 95, 531-7(1954) July 15.

During an extensive series of balloon flights near the geomagnetic equator in India, intensity-depth curves have been obtained with the standard quadruple coincidence counter trains, containing various thicknesses of interposed absorber (4.0 cm, 7.5 cm, and 17.7 cm of Pb), previously utilized at high latitudes. A rather pronounced

difference occurs between the two stations at Aligarh, Uttar Pradesh ( $\lambda$  18°N) and Bangalore, Mysore ( $\lambda$  3°N). The primary flux values, extrapolated to the "top of the atmosphere" from data obtained with instruments containing 7.5 cm of Pb, are  $0.032 \pm 0.001$  and  $0.024 \pm 0.001/\text{cm}^2/\text{sec}/\text{sterad}$ , respectively. A maximum appears in all of the curves, and the general features, as well as the absorption characteristics of the cosmic rays in the upper atmosphere, are in accord with expectation. The effective absorption length in lead, approximately  $290 \text{ g/cm}^2$ , remains unchanged when the geomagnetic cut-off energy of the primary protons is increased from 1.4 Bev to 14.2 Bev. The intensity of mesons having energies exceeding 260 Mev is determined from the data by invoking Messel's theory of the nucleon cascade, and this yields results which are in excellent agreement with the available experimental facts. The primary magnetic-rigidity spectrum averaged over the range 2.1 Bv to 15.4 Bv is  $N(>pc/Ze) = 0.68 (1 + pc/Ze)^{-1.2}$ , based upon the present measurements at 52° N and 3° N. However, the data recorded within the equatorial region require a higher value of the corresponding exponent in the differential distribution if the usual assumptions are valid. This effect may be attributable to an irregularity in the primary spectrum, contributions from trapped orbits and albedo, or local magnetic anomalies. The ratio of intensities in the horizontal and vertical directions at high altitudes is practically equal at 52° N and 3° N, although it would have been expected to increase near the equator in view of the decrease previously observed north of 52°. (auth)

5271  
ENERGETIC NUCLEAR COLLISIONS IN THE UPPER ATMOSPHERE. II. THE MUON COMPONENT. U. Haber-Schaim (Univ. of Bern, Switzerland) and G. Yekutieli (Weizmann Inst. of Science, Rehovoth, Israel). *Nuovo cimento* (9) 11, 683-5(1954) June. (In English). (cf. NSA 8-2508).

The flux of pions in the upper atmosphere calculated in Part I is used to determine the flux of muons in the atmosphere. In particular, the energy spectrum of muons at sea level in the energy band 30 to 1,000  $\text{Mc}^2$  is evaluated and compared with experiment. (auth)

5272  
ENERGY BALANCE OF COSMIC RADIATION NEAR THE EQUATOR. V. Benzi (Univ. of Cagliari, Italy). *Nuovo cimento* (9) 11, 686-7(1954) June. (In Italian).

Three cases are considered in evaluating the loss of energy near the equator (3°N) caused by the formation of a neutrino during the decay of  $\pi$ ,  $\mu$ , and K mesons: (a)  $\pi \rightarrow \mu + \nu$  and  $\mu \rightarrow e + 2 \nu$ ; (b)  $K \rightarrow \mu + \gamma + \nu$ ; and (c)  $K \rightarrow \mu + 2 \nu$ . Experimental results are tabulated and disagree with theoretical results by 33%, 25%, and 20%, respectively. (J.S.R.)

5273  
EXPLOSIONS OF SUPERNOVA AND THE PROBLEM OF THE ORIGIN OF THE ELECTRON COMPONENT OF COSMIC RAYS. I. M. Gordon. *Doklady Akad. Nauk S.S.S.R.* 94, 413-16(1954) Jan. 21. (In Russian)

The hypothesis is advanced that vast quantities of cosmic electrons are produced in the explosions of supernovae. The greater part of the electrons, after dissipation of the shell, increase the electron component of the galactic cosmic rays. (J.S.R.)

5274  
ON THE ABSORBING CHARACTERISTICS OF COSMIC PARTICLES AT DIFFERENT HEIGHTS OF THE ATMOSPHERE. S. N. Vernov, V. A. Gladyshev, V. M. Filatov, A. N. Charakhch'yan, and T. N. Charakhch'yan. *Doklady Akad. Nauk S.S.S.R.* 94, 425-7(1954) Jan. 21. (In Russian)

At the 51° geomagnetic latitude measurements were

made of the number of cosmic particles passing through different filters (1.2, 2.0, and 6.6  $\text{g/cm}^2$  of Al and 11.4, 22.8, and 114  $\text{g/cm}^2$  of Pb). The arrangement of the detection apparatus is shown, and the results of the measurements are graphed. At the greatest heights (pressure less than 60  $\text{g/cm}^2$ ) only 60% of the particles of the soft component of cosmic rays have energy less than  $1.3 \times 10^7$  ev. (J.S.R.)

5275  
ON THE THEORY OF METEOROLOGICAL EFFECTS ON COSMIC RAYS. L. I. Dorman. *Doklady Akad. Nauk S.S.S.R.* 94, 433-6(1954) Jan. 21. (In Russian)

The influence of meteorological conditions on the intensity of cosmic rays was theoretically studied on the basis of the following assumptions: (a) for the best results the formula  $h/\rho = RT$  will be used and not the formula  $h/\rho = \text{constant}$ ; (b)  $\mu$  mesons are not produced by nuclear collisions but are the result of the decay of  $\pi$  mesons formed from primary components; (c) mesons are generated not at a definite level of pressure but in all strata of the atmosphere by definite laws corresponding to the absorption of meson-producing components; (d) the energetic spectrum of the production of  $\pi$  mesons can be calculated. (J.S.R.)

5276  
LATITUDINAL EFFECT OF NUCLEAR FISSION IN THE STRATOSPHERE. V. S. Murzin (Moscow State Univ. im. M. V. Lomonosov, Russia). *Doklady Akad. Nauk S.S.S.R.* 94, 443-6(1954) Jan. 21. (In Russian)

The latitudinal effects of small ionization collisions in the stratosphere was studied at 51, 38, 31, and 0° N and at heights of 23 to 27 km. The results are graphed and tabulated. (J.S.R.)

5277  
PENETRATING SHOWER FROM LEAD AND CARBON. Martin Deutschmann (Max-Planck-Institut für Physik, Göttingen, Germany). *Z. Naturforsch.* 9a, 477-88(1954) June. (In German).

Measurements on 854 penetrating showers of cosmic radiation, which were released by carbon and lead in a cloud chamber, were described. The average energy of these showers was approximately 50 kev. By counting the electron tracks the part of the shower energy emitted in  $\pi^0$  mesons was determined. An integral energy spectrum is obtained, the exponent of which is  $\gamma = 1.5 \pm 0.2$ . The integral distribution of the number of penetrating particles, the multiplicity spectrum, can be described by an exponent  $\delta = 3.8 \pm 0.6$ . It is concluded that the number of penetrating particles increases with the  $\gamma/\delta = 0.4$  power of the primary energy. The energy converted in lead showers is higher by a factor of 1.9 than the energy in carbon showers. The number of penetrating particles from lead and from carbon have a 30% difference; a greater difference exists in the number of strongly ionizing particles which were emitted 5 times as frequently from lead as from carbon. The angular divergence of the lead showers is almost twice as great as that of the carbon showers. (tr-auth)

#### CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE

5278  
POSSIBLE MACROSCOPIC EFFECTS OF SINGLE LATTICE DEFECTS. Jerome Rothstein (Columbia Univ., New York). July 15.

A spiral dislocation with axis perpendicular to the lattice planes of a layer lattice converts the disconnected sheets to a connected helicoid. Crystal properties dependent on propagation effects and so strongly anisotropic in the layered crystal may approach isotropicity as intra-plane parameters can now dominate interplane propagation. A



single defect may thereby have a macroscopic effect on semiconduction and photoconduction, magnetic susceptibility, specific heat, and other properties. Substances in which such effects may exist are listed. (auth)

# ELECTRICAL DISCHARGE

5279

Livermore Research Lab., Calif. Research and Development Co.

VACUUM SPARKING. PART 1. THE EFFECT OF APPLIED RADIOFREQUENCY. O. E. Myers and W. A. Raatz. PART 2. TEST OF IONIC INITIATION HYPOTHESES. O. E. Myers. June 1954. 27p. Contract AT(11-1)-74. (LRL-156)

No departure from vacuum sparking behavior under d-c conditions was observed for frequencies up to 45 megacycles in a small pyrex chamber containing clean Cu electrodes of 0.500-in. sphere sections and evacuated to ca  $10^{-8}$  mm Hg. Potentials up to 80-kv peak were used. It is shown that the results are not inconsistent with a theory of spark initiation which involves field emission of electrons from the cathode which bombard a spot on the anode until Cu is vaporized to form an atmosphere wherein a spark in the usual sense can pass in succeeding radiofrequency cycles. The effect of alpha bombardment of both cathode and anode on the with-standing potential between Cu-Cu and W (cathode)-Cu (anode) electrodes at pressures of the order of  $10^{-8}$  mm Hg appears to be negligibly small. This is not the result predicted by suggested mechanisms which involve charged atoms or groups of atoms, and it is therefore suggested that the original explanation of the vacuum spark initiation by field emission of electrons may be operative under these conditions. This is in agreement with the observed lack of frequency dependence reported earlier; more generally, it appears to be consistent with known facts. (auth)

5280

DIRECT-READING METAL SPECTROSCOPY WITH A D.C. ARC. S. C. Baker (Newcastle Technical College, New South Wales, Australia). *J. Appl. Phys.* **5**, 215-19 (1954) June.

A d.c. globule arc that hisses vigorously has been developed in conjunction with a direct-reading spectrometer built on a wavelength spectrometer and measuring intensity ratios by the null indication of a symmetrical cathode-follower bridge circuit. Self-electrodes are held in massive brass supports with the anode uppermost and the arc run until large molten globules form and stabilize on both electrodes. The relationship between the manganese concentration in carbon steels and the intensity ratio of manganese 4754 Å to iron 5455.6 Å is linear in the range 0.3% to 1.3% manganese, and standard deviations of 2% of content have been obtained. Standard deviations of 4% have been obtained by ordinary photographic photometry using manganese 4754 Å and iron 4707.281 Å. A method of preparing a working curve from a knowledge of the background intensity of the manganese line and a single standard sample is suggested. There is a discontinuity in the volt-ampere characteristic of the arc, but the curve is nearly parallel to the current axis at the operating point. (auth)

# ELECTRONS

5281

ELECTRON STRAGGLING IN THIN FOILS. E. T. Hungerford and R. D. Birkhoff (Univ. of Tennessee, Knoxville). *Phys. Rev.* **95**, 6-7(1954) July 1.

A recent experimental investigation of electron straggling distributions reports disagreement with the distribution half widths of the Landau-Blunck-Leisegang theory. Additional experimental work has been performed in which the angle

of incidence of radiation on the foil has been more carefully controlled and a different method of comparison of theory and experiment has been employed. Discrepancies noted in the previous work with light elements are no longer found. (auth)

5282

THEORY OF SECONDARY ELECTRON CASCADE IN METALS. P. A. Wolff (Bell Telephone Labs., Murray Hill, N. J.). *Phys. Rev.* **95**, 56-66(1954) July 1.

A study is made of the cascade process which describes the diffusion, energy loss, and multiplication of secondary electrons within a metal. The secondaries interact mainly with conduction electrons through a screened Coulomb potential. For low secondary energy (<50 ev) the resultant scattering is nearly spherically symmetric and the transport equation which governs the cascade process can be approximately solved. The velocity distribution turns out to be spherically symmetric for low secondary energy. Energy distributions are in agreement with experiment for metals to which the theory is applicable. Calculations are also made of the rate of change of yield with work function and the results are in accord with observed values. Finally, rough estimates are made of the total yield and the theory is shown to be consistent with the observed values. (auth)

5283

CONTRIBUTIONS OF BREMSSTRAHLUNG CONVERSION IN TRIDENT EXPERIMENTS. M. M. Block and D. T. King (Naval Research Lab., Washington, D. C.). *Phys. Rev.* **95**, 171-4(1954) July 1.

Determinations of the cross section for the direct creation of electron pairs by energetic charged particles in nuclear emulsions are dependent on the experimental criteria by which the observations are accepted, phenomenologically, as tridents. This paper discusses the extent to which materialization of a bremsstrahlung photon close to the path of the parent particle becomes experimentally indistinguishable from direct pair production. A study of 200 pairs arising from the conversion of bremsstrahlung photons from electrons which energies between 0.1 and 10 bev leads to the conclusion that about 6 percent of the pairs materialize so close to their parent that they would be interpreted as tridents. An extension of the analysis to electrons of incident energy 100 bev demonstrates that under typical experimental conditions about 70 percent of such secondary pairs would be accepted as tridents. Recently reported experiments which indicate a cross section for direct pair production by fast electrons much larger than that predicted by theory are discussed. (auth)

5284

MASS OF THE ELECTRON IN QUANTUM ELECTRODYNAMICS. L. D. Landau, A. A. Arbiksov, and I. M. Khalatnikov. *Doklady Akad. Nauk S.S.S.R.* **96**, 261-4(1954) May 11. (In Russian)

5285

INVESTIGATIONS OF THE IONIZING EFFECT OF FAST ELECTRONS. R. Decher and H. Kulenkampff (Physikalisches Institut der Universität, Würzburg, Germany). *Z. Physik* **137**, 638-48(1954) June. (In German).

In a small centrifuge the total specific ionization  $N_t$  (measured with an ionization chamber and collector) and the primary specific ionization  $N_p$  in air (measured with a cloud chamber) were determined for electrons with a kinetic energy of 4.9 Mev. The measurements, converted to 760 mm of Hg and 0°C, were  $N_t = 62.5/\text{cm}$  and  $N_p = 25.4/\text{cm}$ . (tr-auth)

5286

ON THE PROPERTIES OF A SPECTROMETER FOR LINEAR ELECTRON ACCELERATORS. C. C. Grosjean and V. J. Vanhuyse (Rijksuniversiteit, Ghent, Belgium). *Nuovo cimento* (9) **11**, 639-50(1954) June. (In English).

In connection with a specific problem concerning an electron spectrometer, the relativistic equations of motion of an electron in an arbitrary transverse magnetic field with radial symmetry have been solved. A detailed discussion of the exact formulas describing the motion of the particles on their trajectories leads to the following conclusions: the relation between coil current and detected electron energy is invariant; the detected beam current does not directly provide the true energy spectrum, since it is proportional to the product of the beam intensity per unit energy interval times an energy dependent factor; a particular property of the trajectories may possibly lead to a new method for a precision measurement of the electron energy in a monokinetic beam. (auth)

## GASES

5287

RELATIVE IONIZATION YIELDS FOR FISSION FRAGMENTS IN VARIOUS GASES. Lloyd O. Herwig and Glenn H. Miller (Iowa State Coll., Ames). *Phys. Rev.* **95**, 413-17(1954) July 15.

The ionizations resulting from  $U^{238}$  fission have been measured in He, Ne, A, Kr,  $N_2$ , A + 3 percent  $CO_2$ , and A + 5 percent  $N_2$ . Comparison of these values with those obtained for alpha particles in the same chamber fillings permit the calculation of ionization defect differences. It was found that about half of the 7-Mev defect previously ascribed to argon- $CO_2$  mixtures was due to  $CO_2$ . Nitrogen and krypton exhibited relatively large defects. No significant difference was observed between argon and helium. Several possible explanations for this are suggested and discussed. (auth)

## INSTRUMENTS

5288

European Council for Nuclear Research  
MESURES DIRECTES DU CHAMP ET DE SON GRADIENT DANS L'ENTREFER DU MODELE NO. 3. (Direct Measurements of the Field and its Gradient in the Airgap of Model No. 3). [J.] Andersen, [P.] Denis, and [A.] Sarazin. May 1954. 16p. (CERN/PS/MM/2)

A high-precision method of measuring the magnetic field produced in the air gap of a model magnet for the projected CERN synchrotron is described. An accurately positioned search coil was used to measure the field, and a ballistic galvanometer measured the field gradient. The results of several runs are presented. (K.S.)

5289

DuPont de Nemours, E. I., and Co. Explosives Dept. Atomic Energy Div.

A THREE-RUN AUTOMATIC REGISTER. C. A. Prohaska. Apr. 1954. 15p. Contract AT(07-2)-1. (DP-44)

A simple three-run automatic register, to be used with a Tracerlab CC-10 scaler, was designed and built. All electronics were eliminated from the register by making use of the preset count feature incorporated in the scaler. (auth)

5290

Office of Basic Instrumentation, National Bureau of Standards

HIGH-RANGE ACCELEROMETER CALIBRATIONS.

Thomas A. Perls and Charles W. Kissinger. June 1954. 34p. (NBS-3299)

The need for calibrations at high levels of acceleration is discussed. The theory is presented for a method of obtaining such calibrations by impact methods, using an electrical integrator. The method does not require a knowledge of either the pulse shape or the pulse width, although the latter is limited from both above and below by practical considerations related to the integrator and to the accelerometer

under test. Three actual test schemes are described, including the use of a simple ballistic pendulum, an air gun, and an inclined trough. Preliminary data are also presented on a method for obtaining linearity data from steady-state resonant vibrations at levels, so far, up to 1090 g. The steady-state tests established the linearity of one of the NBS 33-14 accelerometers within  $\pm 2\%$  up to 1090 g, and were used for calibration of a commercially available piezoelectric accelerometer within  $\pm 4\%$  up to 665 g. The results of the transient high-g tests on one of the NBS 33-14 accelerometers showed that it becomes strongly nonlinear at -48,000 g, while it has good linearity to at least +40,000 g and -30,000 g. (auth)

5291

Oak Ridge National Lab.

APPARATUS FOR REGULATING CURRENT IN MOVING-BOUNDARY EXPERIMENTS. W. R. Rathkamp and P. S. Baker. June 8, 1954. 6p. Contract W-7405-eng-26. (ORNL-1704)

The apparatus described comprises a half-wave voltage-regulated power supply with 150-, 300-, and 450-v taps and a modified Micromax (Leeds and Northrup Model C) which incorporates a high-transconductance tube. Constant currents with an average deviation of  $\sim 0.04\%$  from any desired value between 2 and 10 ma have been maintained. (L.M.T.)

5292

MOSELEY'S LAW APPLIED TO PROPORTIONAL COUNTER RESOLUTION OF ADJACENT ELEMENTS. C. H. Hendee and S. Fine (Philips Labs., Irvington-on-Hudson, New York). *Phys. Rev.* **95**, 281-2(1954) July 1.

Proportionality between the half width and energy of peaks in the x-ray pulse-height distribution of elements measured by proportional counters has been experimentally verified. The form of the relationship is found to be similar to Moseley's law for the energy of characteristic lines and atomic number. The resolution of a proportional counter for characteristic x rays of adjacent elements is approximately constant over all elements. With a half width of the pulse-height distribution proportional to atomic number, it is suggested that a measurement of the percent half width will provide a means for identifying constituent elements. (K.S.)

5293

SIMPLE, GENERAL-PURPOSE PULSE GENERATOR. Harold A. May (Argonne National Lab., Lemont, Ill.). *Nucleonics* **12**, No. 7, 70-2(1954) July.

A compact, low-cost, general purpose test instrument is described. The negative output pulse is rectangular in shape and has an amplitude continuously variable from 0 to 30 volts at an impedance of 100 ohms. Pulse duration is nominally 1  $\mu$ sec, with rise and fall times of approximately 0.03  $\mu$ sec. The main pulse is delayed 0.5  $\mu$ sec with respect to a positive synchronizing pulse for oscilloscope triggering. This signal is triggered by either internal or external signals in a number of ways, providing great flexibility and convenience in testing or calibration of various types of counters. The pulse repetition rate can be varied from 20 to  $3 \times 10^6$  cpm. (L.T.W.)

5294

DIFFRACTION OF ELECTRONS AT 1 MEV. Moreno Papoular. *Compt. rend.* **238**, 2411-12(1954) June 21. (In French).

An electron diffraction camera of high resolution has been designed for the study of 1-Mev electron diffraction patterns. An electron linear accelerator is used as a source, and an example of electron diffraction in Au is discussed. (K.S.)



## ISOTOPES

5295

DISTILLATION OF "CARRIER-FREE" IODINE-131 ACTIVITY. Milton Kahn, Arthur J. Freedman, and C. G. Shultz (Univ. of New Mexico, Albuquerque). *Nucleonics* 12, No. 7, 72-5(1954) July.

A study of the rate of distillation of carrier-free  $I^{131}$  from aqueous solutions was made to develop a method for the preparation of pure water solution of iodine activity. Approximately 90% of the activity in a solution of carrier-free  $I^{131}$  can be distilled and collected in water according to the described procedure. (L.T.W.)

## MASS SPECTROGRAPHY

5296

MASS SPECTROGRAPHY AND ITS APPLICATION TO PROBLEMS OF ATOMIC AND NUCLEAR CHEMISTRY. (Massenspektrographie Und Ihre Anwendung Auf Probleme Der Atom- Und Kernchemie). J. Mattau. Translated from *Ergeb. exakt. Naturw.* 19, 170-236(1940). 102p. (AEC-tr-1933)

5297

APPLICATION OF MASS SPECTROGRAPHY TO CHEMICAL PROBLEMS. (Mass-spektrografins Tillämpning På Kemiska Problem). Walter Wahl. Translated from *Finska Kemistsamfundets Medd.* 49, 18-41(1940). 38p. (AEC-tr-1934)

5298

MASS SPECTROGRAPHIC ANALYSIS OF SOLIDS. N. B. Hannay and A. J. Ahearn (Bell Telephone Labs., Murray Hill, N. J.). *Anal. Chem.* 26, 1056-8(1954) June.

The capabilities of a Mattau-type mass spectrometer with double focusing and a spark source for the analysis of solids by photographic detection are presented. Typical mass spectra of Sb in Ge, As in Sb, and Au monolayer on Cu are shown. The procedure was tested for semiquantitative analyses with standard samples using radioactive tracers as the added impurity. Calculations were carried out for B in Si and Sb in Ge and plotted as absorbance vs. intensity, showing that after calibration analyses were accurate within an uncertainty factor of 2 or 3. Results indicated that the instrument was capable of semiquantitative analyses at concentrations at least as low as  $10^{-7}$  for most elements. The presence of background lines prevented determination of such elements as C, O, N, and H at low concentrations. Surface contaminants as low as 0.1 monolayer are detectable. Its primary usefulness is for problems not suited for emission spectrographic analysis. (J.A.G.)

## MATHEMATICS

5299

Hanford Works

TABLE OF THE FUNCTION  $K_{j_n}(x) = \frac{1}{x^n} \int_0^x u^n K_0(u) du$ .

G. M. Muller. Jan. 29, 1954. 91p. Contract W-31-109-Eng-52. (HW-30323)

The function  $K_{j_n}(x)$  has been tabulated by IBM methods as an aid in the evaluation of certain integrals arising in transport theory. The applications depend on the fact that

if  $f(x) = \sum C_m x^m$ , then  $\int_0^x K_0(u) f(tu) du = \sum C_m K_{j_m}(x) (tx)^m$ .

The descriptive part of the tables discusses the method of computation, accuracy ( $1$  in  $10^7$ ), and applications. A numerical example is included. (auth)

5300

Oak Ridge National Lab.

NUMERICAL TABLE OF THE CLEBSCH-GORDAN COEFFICIENTS. Albert Simon. June 21, 1954. 30p. Contract W-7405-eng-26. (ORNL-1718)

## MEASURING INSTRUMENTS AND TECHNIQUES

5301

Chalk River Project (Canada)

SMALL HALOGEN-QUENCHED GEIGER COUNTERS DEVELOPMENT WORK TO MARCH 1954. L. A. K. Watt and I. L. Fowler. May 10, 1954. 34p. (CRGP-570)

An account of a development program on small halogen-quenched geiger counters for use in monitors and in radiac instruments is presented. Counters of sensitive volume one inch in length by one quarter inch diameter were developed, which operate at low voltages over a wide temperature range with good stability of characteristics and long lives. (auth)

5302

Joint Establishment for Nuclear Energy Research (Norway) STUDIES ON THE POSSIBILITIES OF USING NUCLEAR PHOTOGRAPHIC EMULSIONS IN CONNECTION WITH REACTORS. Harald B. Klepp and Dragoslav D. Popović. Apr. 1954. 8p. (JENER-25)

A technique is presented for measuring the neutron flux of a reactor with nuclear emulsions. (K.S.)

5303

Knolls Atomic Power Lab.

AN  $(n, \gamma)$  DETECTOR DESIGNED FOR USE WITH A VELOCITY SELECTOR FOR THE STUDY OF LOW ENERGY NEUTRON RESONANCES. R. D. Albert and E. R. Gaertner. Mar. 15, 1954. 47p. Contract W-31-109-Eng-52. (KAPL-1083)

A new type of neutron detector used to study neutron capture with the betatron 100-Mev neutron velocity selector is described. Its use for the investigation of level densities is discussed and illustrated with capture measurements. A procedure for analysis of data to obtain capture level parameters is given. Its use with thick samarium oxide as detector for conventional transmission measurements is also described. (auth)

5304

Livermore Research Lab., Calif. Research and Development Co.

A SCINTILLATION-TYPE ALPHA HAND AND FOOT COUNTER. R. A. Sulit and G. T. Saunders. June 1954. 16p. Contract AT(11-1)-74. (LRL-141)

This report describes an alpha hand and foot counter. The unit employs a simplified scintillation technique and is characterized by ease of construction, dependability, and economy. (auth)

5305

STUDY OF A LIQUID SCINTILLATION COUNTER. D. Brini, L. Peli, O. Rimondi, and P. Veronesi (Univ., Bologna, Italy). *Nuovo cimento* (9) 11, 655-62(1954) June. (In English).

A liquid scintillation counter of small thickness (1 cm) and of circular cross section (10 cm in diameter) was studied. The measurements have shown that its efficiency in revealing relativistic particles is practically 100% and that its real diameter corresponds to the geometric one. The measurements permit the conclusion that the collection of light is about 30% of that emitted in scintillation, with a disuniformity in the light collected not greater than 30%. (auth)

5306

RANGE-ENERGY RELATION IN NUCLEAR TRACK EMULSIONS FOR PROTONS OF ENERGY UP TO 21 MEV. W. M. Gibson (Queen's Univ., Belfast, Ireland), D. J. Prowse (Univ. of Bristol England), and J. Rotblat (Medical College of St. Bartholomew's Hospital, London). *Nature* 173, 1180-1(1954) June 19.

A series of measurements were made on two groups of protons from each of the reactions  $O^{16}(d,p)O^{15}$  and  $C^{12}(d,p)C^{13}$ . The products emitted at angles between  $15^\circ$  and  $165^\circ$  entered photographic emulsions, and the ranges were obtained by

microscopic examination. The energies were obtained from the known  $Q$  values of the reactions, the angles of emission, and the energy of the incident deuterons. The formula  $E = 0.2487R^{0.5868}$  was found to best fit the data,  $E$  being measured in Mev and  $R$  in microns. (L.T.W.)

5307

AUTOMATIC SAMPLE CHANGER FOR WELL-TYPE SCINTILLATION COUNTER. H. L. Demorest and J. H. Erickson (Veterans Administration Hospital, Minneapolis). *Nuclonics* 12, No. 7, 68-9(1954) July.

The unique problem in designing an automatic sample changer for use with a well-type counter is the transfer of liquid-sample vials in glass vials from the storage table to the well of the counter. In the proposed instrument an electromagnetic pickup and release are utilized for the transfer. (L.T.W.)

5308

TEMPERATURE DEPENDENCE OF ORGANIC SCINTILLATION MATERIALS. J. B. Birks (Rhodes Univ., Grahamstown, South Africa). *Phys. Rev.* 95, 277(1954) July 1.

A quantitative photon cascade theory for scintillation processes in organic materials is presented. An experimental plot of the logarithm of the pulse height vs scintillation decay time at various temperatures (103 to 283°K) was previously found to be linear, a result in agreement with this analysis. A predicted value of 3.8  $\mu$ sec for the decay time of anthracene at room temperature is in good agreement with the experimental value of  $3.5 \pm 1.0 \mu$ sec. (K.S.)

5309

A MODIFIED SCINTILLATION PAIR SPECTROMETER. B. Hird and C. Whitehead (Clarendon Lab., Oxford, England). *Proc. Phys. Soc. (London)* A67, 644-5(1954) July.

Discrimination against unwanted  $\gamma$  coincidences in a three-crystal scintillation pair spectrometer has been achieved with a high degree of rejection by introducing apertures on the side crystals which only allow acceptance of pulse heights corresponding to annihilation radiation. (K.S.)

## MESONS

5310

Radiation Lab., Univ. of Calif., Berkeley  
PRODUCTION CROSS SECTIONS FOR POSITIVE AND NEGATIVE PIONS FROM CARBON INITIATED BY 340-MEV PROTONS (thesis). Walter Francis Dudziak. Apr. 1954. 92p. Contract W-7405-eng-48. (UCRL-2564)

Production of  $\pi^+$  and  $\pi^-$  at  $0^\circ$  and  $90^\circ$  to a 340-Mev proton beam has been studied with nuclear emulsions in both uniform and heterogeneous magnetic fields. The peak of the cross section for  $\pi^-$  production at these laboratory angles is at a much lower energy than for  $\pi^+$  production. The maximum pion-energy cutoff for  $\pi^-$  production is smaller than for  $\pi^+$  production. The shapes of the  $\pi^-$ -production spectrum disagree with those previously reported, particularly at low pion energies. At low energies the plots of  $\pi^\pm$  cross sections against pion energy qualitatively resemble corresponding  $\beta^\pm$  decay spectra. Integrating these spectra over the pion energy gives

Angle (lab)	$\frac{d\sigma^+}{d\Omega} \times 10^{28}$	$\frac{d\sigma^-}{d\Omega} \times 10^{28}$	$\frac{\pi^+}{\pi^-}$	$\frac{\pi^+(0^\circ)}{\pi^+(90^\circ)}$	$\frac{\pi^-(0^\circ)}{\pi^-(90^\circ)}$
	cm <sup>2</sup> /ster	cm <sup>2</sup> /ster			
$0^\circ$	$21.0 \pm 0.5$	$0.71 \pm 0.02$	$29.5 \pm 1.2$	$6.3 \pm 0.2$	$1.87 \pm 0.09$
$90^\circ$	$3.35 \pm 0.07$	$0.43 \pm 0.02$	$7.8 \pm 0.4$		

With the aid of Leonard's  $180^\circ$  results on  $\pi^\pm$  from carbon an estimate is made of the total production cross section per C nucleus:  $\sigma_T^+ = (7.6 \pm 0.7) \times 10^{-27}$  cm<sup>2</sup>;  $\sigma_T^- = (0.55 \pm 0.09) \times 10^{-27}$  cm<sup>2</sup>;  $\pi^+/\pi^- = 14 \pm 4$ . The disagreement between

previously published data on  $\pi^+$  production at  $90^\circ$  is resolved for pion energies above 25 Mev. For the calculation of the  $\pi^-$ -production cross section a more appropriate zero-prong correction is 1.35. The spiral-orbit principle is especially suited to the study of charged-pion production at  $90^\circ$  to the proton beam. (auth)

5311

Radiation Lab., Univ. of Calif., Berkeley  
POSITRON SPECTRUM FROM THE DECAY OF THE  $\mu$ -MESON. Ryokichi Sagane, Walter F. Dudziak, and James Vedder. May 25, 1954. 8p. Contract W-7405-eng-48. (UCRL-2596)

The positron spectrum of  $\mu$ -meson decay was measured by a spiral-orbit spectrometer. Some discrepancies with previously reported work were found. The spectrum shows a sharp cutoff at the energy maximum which was found to be  $52.8 \pm 0.2$  Mev. Corresponding meson masses from these measurements give  $m_\mu = 207 \pm 0.8 m_e$ ,  $m_{\pi^+} = 273.4 \pm 1.1 m_e$ . (K.S.)

5312

CLOUD-CHAMBER STUDY OF CHARGED V PARTICLES. Carl M. York, Jr., R. B. Leighton, and E. K. Bjornerud (California Inst. of Tech., Pasadena). *Phys. Rev.* 95, 159-70(1954) July 1.

An analysis of 103 charged V-particle decays is presented. These events have been observed with a double cloud chamber operated at 1750-m altitude. The events in the upper chamber appear to have markedly different properties from those in the lower. The particles in the upper chamber have measured properties which are in every respect consistent with those of the  $\kappa$  meson. Their lifetime is in the range  $5 \times 10^{-10}$  to  $2 \times 10^{-9}$  sec; their mass is  $\sim 1000 m_e$ ; their transverse momentum distribution is consistent with a three-body decay scheme; the momentum in the center-of-mass system of their charged decay products is also consistent with three-body decay; and their frequency of production is greater than 0.4 percent of the total number of shower particles observed. On the other hand, the particles observed in the lower chamber have a lifetime in the range  $10^{-11}$  to  $3 \times 10^{-10}$  sec; their transverse momentum distribution is consistent with a two-body decay scheme; their frequency of production is greater than 0.8 percent of the total number of shower particles; they are observed with approximately one-third of the frequency of  $\Lambda^0$  particles; and they apparently can be produced in meson-nucleon collisions. The majority of the particles in the lower chamber are tentatively identified as charged hyperons with the aid of two cases which appear to have proton secondaries. The proposed decay scheme is  $V_1^+ \rightarrow p + \pi^0 + Q$ ; and in order to fit all of the data, the alternate mode of decay,  $V_1^+ \rightarrow \pi^+ + n + Q$  must be introduced. The  $Q$  value is estimated to be  $\leq 125$  Mev. (auth)

5313

DECAY SCHEME OF THE  $\tau$  MESON. N. Baker and O. Bergmann (Univ. of Adelaide, South Australia). *Phys. Rev.* 95, 174-5(1954) July 1.

A statistical examination of the data at present available on  $\tau$ -meson decay shows that it is consistent with a two-body decay scheme:  $\tau \rightarrow \pi + X^0 \rightarrow \pi + \pi^+ + \pi^-$ . The mass of the intermediate particle  $X^0$  would have to be about  $595 m_e$  and the  $Q$  value for its decay about 22 Mev. (auth)

5314

PHOTOPRODUCTION OF CHARGED PI MESONS FROM HYDROGEN AND DEUTERIUM. T. L. Jenkins, D. Luckey, T. R. Palfrey, and R. R. Wilson (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* 95, 179-84(1954) July 1.

Photoproduction cross sections of charged pi mesons from hydrogen and deuterium have been measured as a function of meson angle at gamma-ray energies of 200, 235, and 265 Mev. The angular range extends from  $30^\circ$



to  $180^\circ$  in the laboratory system. Absolute cross sections have been determined. A least-squares fit of the measured cross sections has been made to the expression  $A + B \cos\theta + C \sin^2\theta$ , which assumes only S and P wave scattering. The coefficients so determined are qualitatively consistent with electric and magnetic dipole absorption together with the assumption of a resonant state of angular momentum  $\frac{3}{2}$  and of energy close to 300 Mev. Comparison with neutral meson production indicates some direct charged meson production in the P state. (auth)

5315

#### INTERACTION OF NEGATIVE PIONS WITH IODINE.

Lester Winsberg (Univ. of Chicago). *Phys. Rev.* **95**, 198-204(1954) July 1.

The interaction of slow negative pions with iodine was studied radiochemically. From the yields of twenty-five radioactive nuclides, yield distribution curves were obtained for the isotopes of each of the seven elements preceding iodine in the periodic table. The total yields of each element and the displacement in mass units of the peak of each distribution from the line of maximum stability were found to be: Te 58 percent (-3), Sb 22 percent (-2), Sn 11 percent (0), In 3 percent (+1), Cd 0.7 percent (+1), Ag 0.12 percent (+2), and Pd 0.03 percent (+3 estimated). The sum of these yields accounts satisfactorily for essentially all the interactions of slow negative pions with iodine. The results reported here are compared with those of other investigations. (auth)

5316

#### EXPERIMENTAL STUDY OF THE $\mu^-$ MESON MASS AND THE VACUUM POLARIZATION IN MESONIC ATOMS.

S. Koslov, V. Fitch, and J. Rainwater (Columbia Univ., New York). *Phys. Rev.* **95**, 291-2(1954) July 1.

Vacuum polarization effects on the determination of the  $\mu^-$  mass from x rays emitted in mesic atom transitions are investigated. The 2P-1S transition in C, 3D-2P transition in P, and the 4F-3D transition in Si were studied, and it is concluded that vacuum polarization effects are necessary for agreement with  $\mu^-$  mass determinations by independent means. (K.S.)

5317

Q VALUE OF  $\Lambda^0$  DECAY. V. A. J. van Lint, G. H. Trilling, R. B. Leighton, and C. D. Anderson (California Inst. of Tech., Pasadena). *Phys. Rev.* **95**, 295-6(1954) July 1.

Cloud chamber photographs of 19  $\Lambda^0$  decays were selected by requiring a heavily ionizing positive secondary whose mass was consistent with a  $\Lambda^0 \rightarrow p + \pi^- + Q$  scheme, and an estimated probable error in the Q value of  $\pm 5$  Mev. An analysis of the tracks produced a value of  $Q = 34.7 \pm 1$  Mev. (K.S.)

5318

#### MESON PRODUCTION IN MESON-NUCLEON COLLISIONS.

B. d'Espagnat (Univ. of Copenhagen, Denmark). *Kgl. Danske Videnskab. Selskab Mat.-fys. Medd.* **28**, No. 11, 1-46(1954).

The production of one meson in meson-nucleon collisions is investigated, with the purpose of expressing the differential and total cross section for the process in terms of the known parameters of elastic meson-nucleon scattering. As little use as possible is made of the questionable approximations of field theory. Particular attention is paid to the reaction in which two positive mesons emerge. A comparison is made with nuclear reactions. Although the two processes are very different, such a comparison still makes it likely that the l, J contribution to meson production (l, relative orbital, J, total angular momentum) is in some rough way proportional to the i, J contribution to elastic scattering. The same conclusion is reached independently through a field theoretical approach; it is therefore believed to be true, although neither of the

two methods is entirely cogent by itself. Formulas are derived for the total cross section for production and the angular distribution of the emergent mesons. The first is considered to give only an order of magnitude, and agrees roughly with what a purely statistical approach to the problem would give. The angular distribution result is further supported by an argument of invariance under rotation of the coordinate system and is therefore considered to have good reliability as long as the l, J expansion remains workable. (auth)

5319

NUCLEON-PION INTERACTIONS. G. Eder. *Acta Phys. Austriaca* **8**, No. 3, 234-75(1954). (In German).

A survey is made of the theoretical analysis of recent experiments with the help of the pseudoscalar meson theory. Nucleon-nucleon interaction, pion production, and pion-nucleon scattering are shown in detail. (210 references) (tr-auth)

5320

#### NUMERICAL CALCULATION IN THE CASCADE THEORY OF THE ENERGY DETERMINATION OF $\pi^0$ MESONS.

Karl Ott (Max-Planck-Institut für Physik, Göttingen, Germany). *Z. Naturforsch.* **9a**, 488-94(1954) June. (In German).

The number of electrons in an electron-photon cascade in lead was numerically calculated as a function of the distance of the shower track for a primary energy  $E_0 = 0.3$  to 300 beV; that is, for the case of primary photons or electrons of energy  $E_0$  and for a primary photon spectrum arising from the  $\pi^0 \rightarrow 2\gamma$  decay of  $\pi^0$  mesons produced by the impact of two nucleons. The results of the electrons distribution in penetrating showers allow the determination, from cloud chamber photographs of such showers, of the energy content of the  $\pi^0$  mesons produced. The electron cascade emitted from a photon spectrum of the bremsstrahlung type was calculated and compared with previous results. The possibility of energy measurement was discussed when the number of particles in the shower nucleus is so great that they cannot be counted. (tr-auth)

5321

ON THE BOND STATE OF  $\pi$  MESONS. Klaus Hain (Max-Planck-Institut für Physik, Göttingen, Germany). *Z. Naturforsch.* **9a**, 495-508(1954) June. (In German).

The possibility was investigated of whether two pseudoscalar  $\pi$  mesons originating from the interaction of a nucleon with an antinucleon field can have a bound state. The selection rule permits a state of spin  $l = 1$  from different charged  $\pi$  mesons with a wave function which is symmetric in relative time and antimetric in isotopic spin. The selection rule also permits a state of the spin  $l = 1$ , composed of similar  $\pi$  mesons, which is antimetric in relative time and in transformed by a space-time reflection as a pseudovector. The transformation of this two-meson wave function to the nucleon-antinucleon function shows that it contains a relativistic effect. The calculations in the first theoretical perturbation approximation show that the interaction of two particles consist of a repelling  $\delta$  force which can serve for the classification of the neutralization of the nuclear force when it corresponds to the nonlinear term in the Schiff equation and an attractive force from the range of the Compton half wave length of protons which suggests the possibility that the lowest bound state can have a spin  $l = 1$ . The Bethe-Salpeter equation is solved with this interaction by a Ritz method obtaining, as a condition of the existence of a bound state, a coupling constant for different charged  $\pi$  mesons approximately 14 and for neutral mesons, in which the wave function is antimetric in relative time, approximately 8. The first double-vector meson can

serve possibly for the classification of spin-path coupling. (tr-auth)

5322

$\mu$ -MESON SCATTERING AND CHARGE DISTRIBUTION IN ATOMIC NUCLEI. Hans Marschall (Univ. of Marburg/Lahn, Germany). *Z. Physik* **138**, 93-104(1954) June 21. (In German)

Because of the weak coupling of the  $\mu$  meson to the nuclear field, the possible description of the interaction of these mesons with nuclei by electrodynamic force serves as the basis of a simple calculation of the elastic scattering of  $\mu$  mesons by nuclei. By neglect of the relativistic effect the interaction was described by a Coulomb field, and the calculation of the scattering distribution was done by means of the Mott partial wave method, whereby the single partial waves in the Wentzel-Kramers-Brillouin approximation were calculated. The calculations were made for meson energies of 25 and 50 Mev for both extreme cases of a homogeneous proton distribution in the nucleus and of a surface charge, with the object of investigating the sensitivity of the scattering distribution in contrast to the variation of the charge distribution during the change of the nuclear radius. By the use of positively charged  $\mu$  mesons of appropriately selected energy it appears possible to obtain, from the scattering distribution, information concerning the proton distribution in the nucleus. (tr-auth)

5323

INTERACTION OF  $\pi^+$  MESONS IN PHOTOGRAPHIC PLATES. II. A. Minguzzi, G. Puppi, and A. Ranzi (Univ. of Bologna, Italy, and Istituto Nazionale di Fisica Nucleare, Sezione di Padova, Italy). *Nuovo cimento* (9) **11**, 697-700 (1954) June. (In English). (cf. NSA 8-1657).

An analysis of 197 pion events in nuclear emulsions exposed to a 62-Mev  $\pi^+$  beam was undertaken in order to study any correlation between the observed scattering processes and elementary meson-nucleon scattering. The fractional loss of energy of the pion ( $\Delta E/E$ ) was measured, and a distribution of the elastic and inelastic events shows a broad inelastic group present at all fractional losses whereas the elastic group is symmetrically distributed in a peak about  $\Delta E/E = 0$ , containing a group of backward-scattered particles. It is pointed out that such effects cannot be explained by a complex potential of central forces of the type  $(V + iS) f(r)$ . For the observed inelastic events, the most reasonable interpretation of the pion scatterings seems to be in terms of individual meson-nucleon scattering where the nucleon retains the properties of interaction in the free state without nonlinear effects. (K.S.)

5324

ANGULAR DISTRIBUTION OF  $\pi$  MESONS PRODUCED BY POLARIZED NUCLEONS. V. B. Berestetskii. *Doklady Akad. Nauk S.S.S.R.* **94**, 421-3(1954) Jan. 21. (In Russian)

It is shown that the angular distribution of  $\pi$  mesons produced by polarized nucleons with low energy eventually maintains the interference from the S and P condition of the meson, reducing the characteristic azimuthal asymmetry. (J.S.R.)

5325

POLYPHENOMENOLOGICAL THEORIES OF THE GENERATION OF  $\pi$ -MESON PAIRS BY  $\gamma$  QUANTA AT HIGH ENERGIES. I. Ya. Pomeranchuk. *Doklady Akad. Nauk S.S.S.R.* **96**, 265-8(1954) May 11. (In Russian)

A polyphenomenological theory of the generation of  $\pi$ -meson pairs by  $\gamma$  quanta at high energies was constructed, analogous to the theory of  $\gamma$ -quanta emission with  $\pi$  mesons. A comparison between the theory and experimental data introduces new factors concerning the interaction of  $\pi^+$  and  $\pi^-$  particles and their dimensions. (J.S.R.)

## MOLECULAR PROPERTIES

5326

SEMIEMPIRICAL POTENTIAL ENERGY FUNCTIONS. I. THE  $H_2$  AND  $H_2^+$  DIATOMIC MOLECULES. Arthur A. Frost and Boris Musulin (Northwestern Univ., Evanston, Ill.). *J. Chem. Phys.* **22**, 1017-20(1954) June.

After setting up certain theoretical criteria for a semiempirical potential energy function, two such functions for  $H_2^+$  and  $H_2$  are constructed, the simplest of which has the form  $V = e^{-aR}(e^2/R - b)$ , where  $V$  is the potential energy with its zero corresponding to infinite separation,  $R$  is the internuclear distance,  $e$  the electronic charge, and  $a$  and  $b$  parameters. This function is used to correlate the experimental quantities: dissociation energy, equilibrium internuclear distance, force constant, third and fourth derivatives of  $V$  with respect to  $R$ ; united atom energy, and critical distance. A more complicated function is also presented which with one molecular parameter fixed by the dissociation energy is capable of then predicting internuclear distance and force constant. (auth)

## NEUTRONS

5327

POLARIZATION IN HIGH-ENERGY p-n-n DOUBLE SCATTERING. Peter Hillman, Vaughn Culler, and N. F. Ramsey (Harvard Univ, Cambridge, Mass.). *Phys. Rev.* **95**, 462-3(1954) July 15.

An exploratory polarization experiment on the double scattering of high-energy neutrons has been performed. A 100-Mev proton beam gives exchange neutrons in the first scattering, and these neutrons are rescattered and counted. Two high-efficiency liquid scintillation counters are used to detect the neutrons, which have an average effective counted energy of about 45 Mev. Various combinations of scatterers were used. In all cases the asymmetry  $2e$  was less than 6 percent. (auth)

5328

"FAST CHOPPER" TIME-OF-FLIGHT MEASUREMENT OF NEUTRON RESONANCES. F. G. P. Seidl, D. J. Hughes, H. Palevsky, J. S. Levin, W. Y. Kato, and N. G. Sjöstrand (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **95**, 476-99(1954) July 15.

A high-resolution neutron velocity selector, or "fast chopper," has been constructed and is in routine operation at the Brookhaven reactor. It consists of a high-speed rotor that produces bursts of neutrons of about 1- $\mu$ sec duration, together with a neutron detector at the end of a 20-meter flight path and circuits with which the time of flight is measured. The construction and operating characteristics of the equipment are described briefly. The methods that are used for analysis of sample transmission curves in the energy regions of good and of poor resolution are presented, together with curves used to correct for the effects of Doppler broadening and sample thickness. In the good resolution region the measured total cross section in the vicinity of a resonance can be interpreted to give the total width  $\Gamma$  and  $g\Gamma_n$ . In the poor resolution region only the quantity  $\sigma_0\Gamma^2$ , which is proportional to  $g\Gamma_n\Gamma$ , is obtained. Measured parameters for levels in the 2 to 200 ev energy region are given for silver, iodine, thorium, gold, manganese, and cobalt. The results are compared with theoretical expectations. (auth)

5329

TWO-GROUP PERTURBATION THEORY IN NEUTRON TRANSPORT THEORY. J. H. Taft (Atomic Energy Research Establishment, Harwell, Berks, England). *Proc. Phys. Soc. (London)* **A67**, 615-21(1954) July.

The application of perturbation theory to two-velocity-group neutron problems is described. The exact integral equations satisfied by the neutron densities are considered.



The treatment is, therefore, not restricted to systems whose dimensions are large compared with the relevant mean free paths, and is more general than that reported by Glasstone and Edlund. The latter describe a theory, due to Wigner, in which it is assumed that the neutron densities satisfy the diffusion equations, i.e. the theory is applicable only to large systems. The eigenfunctions of the integral equations do not form an orthogonal set. They are orthogonal to the eigenfunctions of the adjoint equations. The first part of the paper deals with the construction of these latter equations. The variation of the eigenvalue of the integral equations with small changes in the system is calculated. Finally formulae are obtained for the multiplication of a source of neutrons in a system near to critical. The theory described in this paper is a generalization of that given by Fuchs for application to one-group-theory problems. The pattern of the analysis is similar, but deviates in the treatment of the effect of a change in the neutron mean free path in the system. (auth)

5330

AN EASILY REPRODUCIBLE DENSITY STANDARD FOR THERMAL NEUTRONS. René Cohen and Roland Barloutaud. *Compt. rend.* **238**, 2413-14(1954) June 21. (In French).

A density standard for thermal neutrons of simple design and low cost is proposed. The standard is reproducible to better than 1.5%, and provides a simple method for comparing various local standards. The absolute value of this density, determined from measurements with the Châtillon pile, is  $(5.70 \pm 0.19) \times 10^{-3}$  n/cm<sup>2</sup>. (tr-auth)

## NUCLEAR PHYSICS

5331

Ames Lab.  
QUARTERLY SUMMARY RESEARCH REPORT IN PHYSICS FOR JANUARY, FEBRUARY, AND MARCH 1954. June 28, 1954. 14p. Contract W-7405-eng-82. (ISC-487)

New data are reported for the  $\beta$  and  $\gamma$  radiations of Ce<sup>141</sup>. No deviation from a straight line was observed in the lower-energy  $\beta$  groups of Rb<sup>86</sup> and Tm<sup>170</sup>. A large number of three-prong photodisintegration stars were studied in nuclear emulsions. The reactions were C<sup>12</sup>( $\gamma$ ,3 $\alpha$ ). The heat of sublimation of vacuum-distilled Dy metal was measured from two runs, giving  $H = 68.4$  and  $68.0$  kcal/mole. (For preceding period see ISC-451.) (K.S.)

5332

INTERACTIONS BETWEEN SOME TWO-NUCLEON CONFIGURATIONS. Martin G. Redlich (Princeton Univ., N. J.). *Phys. Rev.* **95**, 448-52(1954) July 15.

The shell model wave functions may often be mixtures of those for two or more configurations. Calculations based upon a harmonic oscillator central potential with scalar Gaussian interactions between nucleons indicate that there is substantial interaction between various two-nucleon configurations of the  $1d_{5/2}$ ,  $2s_{1/2}$ ,  $1d_{3/2}$  shell. The admixtures of the  $1f_{7/2}$  subshell, which belongs to the next main level, are, however, small. A mixture of several neighboring configurations accounts for the ft value of  $F^{18}(\beta^+)O^{18}$  better than any single configuration. (auth)

## NUCLEAR PROPERTIES

5333

SEPARATION OF THE ISOTOPES OF TECHNETIUM AND IDENTIFICATION OF THE MASS NUMBER OF AN ISOMERIC TRANSITION OF 390 KEV. M. R. Bernas and J. Beydon. *J. phys. radium* **15**, 31-2S(1954) June. (In French)

Targets of metallic Mo were irradiated with deuterons. The Tc and Mo were chemically separated, and an isotopic separation of Tc was performed. Mass numbers of 92, 93,

and 94 were observed. The 390-Kev isomeric transition was observed only in Tc<sup>93</sup>. (J.S.R.)

5334

ON THE DETERMINATION OF NEW ENERGY LEVELS IN Be<sup>10</sup>. J. J. Jung, C. K. Bockelman, and W. W. Buechner. *J. phys. radium* **15**, 50S(1954) June. (In French)

The energy levels of Be<sup>10</sup> were studied by means of the reaction Be<sup>9</sup>(d,p)Be<sup>10</sup> with the energy of the incident deuteron beam between 5.4 and 7.6 Mev. The levels are diagramed. A previously reported 6.2-Mev level is composed in reality, of three levels of 5.95, 6.18, and 6.26 Mev. (J.S.R.)

5335

ON GAUGE INVARIANCE AND THE STRUCTURE OF ELEMENTARY PARTICLES. Yasushi Takahashi (Nagoya Univ., Japan). *Progr. Theoret. Phys. (Japan)* **11**, 251-63(1954) March.

Non-gauge terms inherent in current field theory are discussed. An identity which holds, independently of the definition of integration, between the non-gauge term and the vacuum expectation value of the energy-momentum tensor of vacuum particles is derived and its physical meaning is discussed. (auth)

5336

ON THE STRUCTURE OF THE INTERACTION OF THE ELEMENTARY PARTICLES. V. INTERACTION OF THE SECOND KIND AND NON-LOCAL INTERACTION. Susumu Kamefuchi (Nagoya Univ., Japan). *Progr. Theoret. Phys. (Japan)* **11**, 273-87(1954) March. (cf. NSA 7-5663)

By extending the idea of the previous paper to the case of vertex corrections, the extent to which the theory can be made less singular is examined. Detailed discussions are given for the easiest example, namely, the 4 vertex-interaction in meson-pair theory. For this interaction it is required to introduce the infinite number of counter terms, which can, however, be brought into the form of non-local interactions. Thus, although the theory thus obtained may not be closed, the finite results of such a procedure can be obtained. Lastly, some remarks are briefly stated in connection with other approaches to the non-singular theory. (auth)

5337

THE EFFECT OF THE MASS DIFFERENCE BETWEEN CHARGED AND NEUTRAL PIONS ON THE NUCLEAR FORCE. Atsushi Sugie (Univ. of Tokyo, Japan). *Progr. Theoret. Phys. (Japan)* **11**, 333-4(1954) Mar.

5338

MAGNETIC MOMENT OF Os<sup>189</sup>. H. R. Loeliger and L. R. Sarles (Stanford Univ., California). *Phys. Rev.* **95**, 291 (1954) July 1.

Molten OsO<sub>4</sub> was chosen to measure the magnetic moment of Os<sup>189</sup>. The spin was verified to be  $\frac{3}{2}$ , and  $\mu = +0.650655$  nm. (K.S.)

5339

EVIDENCE FOR SUBSHELL AT N = 152. A. Ghiorso, S. G. Thompson, G. H. Higgins, B. G. Harvey, and G. T. Seaborg (Univ. of California, Berkeley). *Phys. Rev.* **95**, 293-5(1954) July 1.

A method of searching for subshell effects by the observation of breaks in a plot of  $\alpha$ -particle energy vs. mass number is described. Such a plot for the isotopes of Cf shows a break in the region of Cf<sup>250</sup> to Cf<sup>252</sup>, indicating a subshell at 152 neutrons. (K.S.)

5340

COULOMB ENERGY AND NUCLEAR RADIUS. B. G. Jancovici (Princeton Univ., N. J.). *Phys. Rev.* **95**, 389-92(1954) July 15.

The apparent discrepancy between the values  $(1.45 \times 10^{-13} \text{ A}^{1/2} \text{ cm})$  for the nuclear radii derived from mirror

nuclei and those ( $1.2 \times 10^{-13} \text{ A}^{1/2} \text{ cm}$ ) derived from  $\mu$ -mesonic atoms was investigated. The conventional calculation of the Coulomb energy difference  $\Delta E_C$  between mirror nuclei is improved in two respects: the usual uniform model is replaced by the more elaborate shell model with a finite square well potential, and the exchange terms are taken into account. An equivalent Coulomb radius  $R_C$  is defined by  $R_C = (6/5) (Ze^2/\Delta E_C)$ ; an equivalent meson radius is defined by  $R_M = (5/3)^{1/2} \langle r^2 \rangle_{AV}^{1/2}$ , where  $\langle r^2 \rangle_{AV}^{1/2}$  is the mean square radius of the electrical charge distribution. The two extreme cases of the pairs ( $F^{17}$ ,  $O^{17}$ ) and ( $O^{15}$ ,  $N^{15}$ ) are investigated. The computation gives  $R_C/R_M = 1.18$  in  $O^{17}$ ,  $R_C/R_M = 1.07$  in  $N^{15}$ . These results are smaller by about 8 percent than the experimental ratios. However, the experimental discontinuity in  $R_C$  at the closure of the p shell is reproduced. (auth)

5341

INDEPENDENT PARTICLE MODEL AND THE NUCLEAR PHOTOEFFECT. J. S. Levinger and D. C. Kent (Louisiana State Univ., Baton Rouge). Phys. Rev. **95**, 418-24(1954) July 15.

The very low value calculated by Levinger and Bethe for the harmonic mean energy for the nuclear photoeffect is increased by a factor of 3 for Cu and 4 for Ta if correlations between nucleons due to the Pauli principle are included in the calculation using an independent particle model (IPM). Our calculation removes the discrepancy between the sum-rule result and Burkhardt's calculation using the IPM for Cu. If we use a smaller nuclear radius, and include the increase of mean energy due to exchange forces, we find reasonable agreement between experimental results for Cu and Ta and the harmonic mean energies calculated for an IPM in a finite square well: i.e., 18 Mev for Cu and 12 Mev for Ta. (auth)

5342

NONLINEAR MESON EQUATION AND SATURATION OF NUCLEAR FORCES. P. Mittelstaedt (Max-Planck Institut für Physik, Göttingen, Germany). Z. Physik **137**, 545-71 (1954) June. (In German).

By means of the Schiff and Thirring differential equation  $\Delta \phi(r) - \mu^2 \phi(r) - \lambda g^4 \phi^3(r) = -g\rho(r)$  for the potential function of nuclear force, the binding energies of heavy and light nuclei were determined. For the heavy nuclei the Thomas-Fermi model was used; for some light nuclei ( $He^4$ ,  $O^{16}$ ,  $Ca^{40}$ ) the shell model was used. The coupling constant  $g$  as well as the constant  $\lambda$  were determined for the nonlinear terms. In the calculation of the binding energies with these constants the surface energy and the Coulomb energy were determined. The results showed good agreement with the value from the semi-empirical Weizsacke-Bethe formula. The calculated thickness of the nucleons and the width of the surface area agreed with earlier results. (tr-auth)

5343

MAGNETIC MOMENT OF  $Ge^{73}$ . S. I. Aksenov and K. V. Vladimirovskii. Doklady Akad. Nauk S.S.S.R. **96**, 37-8(1954) May 1. (In Russian)

The nuclear magnetic resonance of  $Ge^{73}$  in  $GeCl_4$  was measured with respect to that of D at a frequency of 1527 kc in a field of 10,300 gauss. The ratio of the frequencies was  $\frac{\nu_{Ge^{73}}}{\nu_D} = 0.22724 \pm 0.00002$ . From this ratio the magnetic moment was calculated to be  $|\mu(Ge^{73})| = 0.87677 \pm 0.00009$  magneton. (J.S.R.)

5344

THE DETERMINATION OF THE ENERGY OF PROTON GAMMA RESONANCES AND THEIR USE TO CHECK THEORIES OF NUCLEAR STRUCTURE. II. S. E. Hunt (Associated Electrical Industries Ltd., Aldermaston,

Berkshire, England). Atomica **5**, 191-4(1954) July. (cf. NSA 8-4697)

The distribution of excited energy levels in the nucleus has not yet been completely explained theoretically, partly because of a lack of knowledge of the nature of the inter-nucleonic forces, and partly because of the complexity of the problem. Attempts have been made to simplify the problem by considering the nucleus as analogous to other dynamical systems, and the success and limitations of some of these nuclear models is discussed. (auth)

5345

STATISTICS OF NUCLEAR LEVELS. J. M. B. Lang and K. J. Le Couteur (Univ. of Liverpool, England). Proc. Phys. Soc. (London) **A67**, 586-600(1954) July.

All the available experimental evidence relating to the statistical distribution of dense nuclear levels is collected together and analysed. The simplest adequate nuclear equation of state is  $U = \frac{1}{11} At^2 - t + \frac{1}{8} A^{1/2} t^{1/2}$  Mev which leads to  $D_0 = 0.11 A^2 (U + t)^2 \exp \{-2(AU/11)^{1/2} + \frac{3}{32} (11U)^{3/2}\}$  Mev for the spacing of levels of zero angular momentum. The significance of these formulae is discussed. An appendix refines the theoretical level density formula for a Fermi gas with a fixed number of particles; this analysis incidentally yields a slightly more accurate form of the simple Hardy-Ramanujan asymptotic formula for the number of partitions of a positive integer. (auth)

5346

SPECTROSCOPIC ISOTOPE SHIFT AND NUCLEAR DEFORMATIONS. A. R. Bodmer (Univ. of Manchester, England). Proc. Phys. Soc. (London) **A67**, 622-31(1954) July. (cf. NSA 8-929).

With a method developed in a previous paper the isotope shift due to a difference in nuclear deformation of two isotopes is calculated, making certain simplifying assumptions about the nuclear charge distribution. If both isotopes have a spectroscopic quadrupole moment these may then be used to make an estimate of the deformations. It is found that the difference between the intrinsic and spectroscopic quadrupole moments is quite crucial and that when this is taken into account the anomalously large isotope shift of Eu is satisfactorily explained with the experimentally determined quadrupole moments. Using available data on quadrupole and magnetic moments, a tentative examination of other isotope shift data in terms of the deformation dependent isotope shift indicates that this may perhaps explain the large observed variations. (auth)

5347

ON THE NUCLEAR LEVELS OF  $Mo^{93}$ . Christiane Levi and Lily Papineau. Compt. rend. **238**, 2313-16(1954) June 14. (In French)

The  $Tc^{93}$  activities with periods of 2.7 hr and 45 min were studied by isotopic separation, scintillation  $\gamma$  spectrometry,  $\beta$  spectrometry, and  $\beta$ - $\gamma$  and  $\gamma$ - $\gamma$  coincidences. The  $\beta^+$  spectrum of the 2.7-hr activity is composed of two permitted spectra. Information was obtained on the excited states of  $Mo^{93}$ . (tr-auth)

#### NUCLEAR REACTORS

5348

Atomic Electric Project, St. Louis  
A STUDY OF FAVORABLE DESIGN VALUES FOR A REACTOR OPERATED FOR POWER GENERATION ONLY. Estel M. Mabuice and Kenneth A. Hub. Atomic Electric Project, St. Louis, [Composed of Monsanto Chemical Co. and Union Electric Co. of Mo.]. Sept. 30, 1953. 70p. (AEP-99)

The economics of commercial power production are investigated by an idealized study of a Na-cooled, graphite-moderated reactor. A design outline is presented which is



generally applicable to any other reactor type. Specifically, net costs per kwh and net fuel costs are examined in connection with a choice of favorable steam pressure. With an assumed capital cost and a net fuel cost in the range of 0 to 20¢/10<sup>6</sup> Btu, steam pressures near 800 psia appear most feasible, provided a superheated steam cycle is used. Overall efficiencies of 34% are indicated. It is pointed out that the coolant volume must represent a compromise between maximum heat transfer, heat transfer at a temperature favorable to the steam cycle, and reduction of neutron absorption in the coolant. (K.S.)

5349

Joint Establishment for Nuclear Energy Research (Norway) INVESTIGATIONS OF  $\beta$ -ACTIVITIES IN THE HEAVY WATER OF JEEP CARRIED OUT IN THE PERIOD OF JUNE 1 TO AUGUST 8, 1953. Th. Sikkeland. May 1954. 11p. (JENER-26)

Radiochemical methods have been used to detect the presence of active Cu, Fe, Ca, K, and Na isotopes in the D<sub>2</sub>O of the JEEP reactor. Calculated concentrations were found to be of the same order of magnitude as found spectrographically. C<sup>14</sup> was detected in a concentration similar to that expected from a N<sup>14</sup> (n,p) reaction. (K.S.)

5350

Knolls Atomic Power Lab. A DETERMINATION OF THE NEUTRON TEMPERATURE AT THE CENTER OF THE THERMAL TEST REACTOR. G. B. Gavin. June 22, 1954. 37p. Contract W-31-109-eng-52. (KAPL-1142)

The effective temperature of the thermal neutrons at the center of the internal column of the Thermal Test Reactor has been measured by means of a danger coefficient technique. Assuming that the thermal neutrons have a Maxwellian velocity distribution, the experiments indicated that the TTR neutrons have a Kelvin temperature of 300°. The unique relation which exists between a 1/v and a non 1/v neutrons absorber for neutron capture as a function of energy is the underlying principle upon which the experimental technique is based. The physical temperature of the reactor during the period of experimentation was also measured as 300°K. (auth)

5351

Livermore Research Lab., Calif. Research and Development Co. DESCRIPTION AND STARTUP OF A WATER BOILER REACTOR. J. W. Shortall, J. W. Flora, R. H. Graham, and A. V. Shelton. June 1954. 49p. Contract AT(11-1)-74. (LRL-136)

A "water boiler" type reactor has been installed at the Livermore Research Laboratory. The reactor was designed and constructed by North American Aviation, Inc., for the Atomic Energy Commission as a neutron source for the California Research and Development Company. A detailed description of the reactor, critical experiment, and preliminary operating characteristics are given. (auth)

5352

Livermore Research Lab., Calif. Research and Development Co. TEMPERATURE EFFECT ON REACTIVITY OF THE CR&D WATER BOILER. J. W. Flora, J. W. Shortall, and W. E. Drummond. June 1954. 35p. Contract AT(11-1)-74. (LRL-148)

The temperature coefficient of reactivity of the California Research and Development Company Water Boiler reactor has been measured as minus 0.026 per cent  $\Delta k$  per degree centigrade between 10.8 and 37.7 degrees centigrade. As an extension of this measurement the boiler was allowed to rise, being limited only by temperature, on three successive shorter periods and the peak power attained was noted.

For excess k's of 0.126, 0.177 and 0.269 per cent maximum powers attained were 3.1, 5.8 and 15.8 kilowatts, respectively. In addition, a power-temperature oscillation experiment was performed. (auth)

5353

Livermore Research Lab., Calif. Research and Development Co. POWER CALIBRATION OF THE WATER BOILER NUCLEAR REACTOR. J. W. Shortall, J. W. Flora, R. H. Graham, and E. J. Strain. June 1954. 24p. Contract AT(11-1)-74. (LRL-149)

The power of the CR&D water boiler reactor has been calibrated by three independent methods to 500 watts  $\pm 6$  per cent for 95 per cent confidence limits. The three techniques were: activation of standardized gold foils, radiochemical analyses of activated uranium foils to determine the fission product yields of Ba<sup>138</sup> and Zr<sup>97</sup>, and calorimetry. These methods gave answers in agreement to within 13 per cent. The thermal neutron flux at 500 watts is  $2.11 \times 10^{10}$  neutrons/cm<sup>2</sup>/sec in the center of the spherical core. The report includes a brief description of the reactor, discussion of the three methods used to calibrate the power, and presentation of the results. (auth)

5354

Livermore Research Lab., Calif. Research and Development Co. OPERATING CHARACTERISTICS OF THE WATER BOILER. J. W. Flora, J. W. Shortall, and E. J. Strain. June 1954. 44p. Contract AT(11-1)-74. (LRL-151)

The California Research & Development Company's Water Boiler reactor has been operated approximately 100 kilowatt hours. The characteristics of the reactor that have been observed are reported. Information is included on volatile fission-product buildup and decay, effect of voids in the reflector, danger coefficient values, control-rod calibration, response time of safety circuits, neutron and gamma-ray distribution, etc. (auth)

5355

Livermore Research Lab., Calif. Research and Development Co. EXPERIMENTAL FACILITIES OF THE WATER BOILER. J. W. Flora and J. W. Shortall. June 1954. 34p. Contract AT(11-1)-74. (LRL-152)

The experimental facilities provided by the CR&D Company's water boiler reactor have been examined experimentally. Neutron distributions and cadmium ratios of interest in sample exposures are reported. Absolute flux values are assigned. Neutron and gamma ray beam intensities have been investigated. Some conclusions are presented as to performance and possible improvements of the facilities. (auth)

5356

Livermore Research Lab., Calif. Research and Development Co. THEORETICAL STUDY OF FISSION PRODUCT GASEOUS ACTIVITY FROM A HOMOGENEOUS REACTOR. J. R. Donaldson. June 1954. 15p. Contract AT(11-1)-74. (LRL-153)

Buildup of the gaseous radioisotopes which are expected to be found in the atmosphere above a solution-fueled reactor has been calculated as a function of operating time. Krypton, iodine, xenon, and bromine have been considered. Direct fission and daughter yields are included in the summations of activities. Decay upon shutdown following various periods of equilibrium operation are tabulated. (auth)

5357

LIQUID METAL FUEL REACTOR SYSTEMS FOR POWER. C. Williams and F. T. Miles (Brookhaven National Lab., Upton, N. Y.). *Nucleonics* 12, No. 7, 11-13(1954) July.

The present status of the LMFR program at Brookhaven is summarized, and general problems associated with the reactor design are discussed. (K.S.)

5358

# LIQUID-METAL FUELS AND BREEDER BLANKETS.

R. J. Teitel, D. H. Gurinsky, and J. S. Bryner (Brookhaven National Lab., Upton, N. Y.). *Nucleonics* 12, No. 7, 14-15(1954) July.

U and Th solutions and dispersions with Bi, Sn, and Pb are reviewed from the standpoint of their applicability as liquid metal fuel and blanket material. The solubilities of U and Th in various combinations of liquid metal diluents are given. (K.S.)

5359

# FUSED SALTS FOR REMOVING FISSION PRODUCTS

FROM U-Bi FUELS. D. W. Bareis, R. H. Wiswall, Jr., and W. E. Winsche (Brookhaven National Lab., Upton, N. Y.). *Nucleonics* 12, No. 7, 16-19(1954) July.

Experiments indicating the feasibility of extracting fission products from LMFR's U-Bi fuel solution by treating it with a fused salt are reported. Theories involving known properties of rare-earth compounds substantiate experiment. (L.T.W.)

5360

FUEL PROCESSING LOOPS: HOW THEY ARE BEING DEVELOPED. C. Raseman and J. Weisman (Brookhaven National Lab., Upton, N. Y.). *Nucleonics* 12, No. 7, 20-5 (1954) July.

Tests run to develop components and processing techniques for the in-pile facility, designed to prove the feasibility of salt extraction of rare earth fission products from liquid metal fuel, are described. (L.T.W.)

5361

A CONTINUOUSLY SEPARATING BREEDER BLANKET USING ThF<sub>4</sub>. F. T. Miles, R. H. Wiswall, R. J. Heus, and L. P. Hatch (Brookhaven National Lab., Upton, N. Y.). *Nucleonics* 12, No. 7, 26-9(1954) July.

Continuous removal of UF<sub>6</sub> from a fixed bed of ThF<sub>4</sub> is possible, but gas cooling of the bed is difficult. A similar process conducted outside the reactor appears more promising and also lessens the corrosion problem. (L.T.W.)

5362

HEAT EXCHANGE IN LMF POWER REACTOR SYSTEMS. Orrington E. Dwyer (Brookhaven National Lab., Upton, N. Y.). *Nucleonics* 12, No. 7, 30-9(1954) July.

Underlying principles and factors affecting design of heat-transfer components in LMFR's are discussed. Calculations are presented for typical system designs. (L.T.W.)

5363

FINDING A CONTAINER MATERIAL FOR THE URANIUM-BISMUTH FUEL SYSTEM. D. H. Gurinsky, J. E. Atherton, O. F. Kammerer, C. Klamut, M. Silberberg, B. Turovlin, and J. Weeks (Brookhaven National Lab., Upton, N. Y.). *Nucleonics* 12, No. 7, 40-2(1954) July.

Behavior of steel in contact with Bi-U solutions, effects of graphite and steels on fuel stability, and effects of additives on mass transfer are shown. (L.T.W.)

5364

DIRECT STEAM GENERATION FOR POWER. Samuel Untermyer (Argonne National Lab., Lemont, Ill.). *Nucleonics* 12, No. 7, 43-7(1954) July.

Experiments prove that boiling, originally thought to make reactors unstable, can provide self-regulation of a reactor and at the same time directly transfer reactor heat to steam capable of driving a power-generating turbine. Elimination of secondary coolant system provides economic and technical advantages. (L.T.W.)

5365

ON THE ANALYSIS OF EXPERIMENTS INVOLVING THE KINETICS OF PILES WITH REFLECTORS. V. H. Rumsey (Ohio State Univ., Columbus). *Can. J. Phys.* 32, 435-49 (1954) July.

The theory of pile kinetics is used to analyze measurements of the mean lifetime and migration length of neutrons. The purpose is to show what effects need to be taken into account in the analysis of pile experiments rather than to give a precise experimental verification of the theory. It is shown that the bare-pile one-group model is not adequate. A two-group model which takes into account the presence of the reflector is used to obtain a more accurate analysis. The orders of magnitude are illustrated by deriving formulas for a specific pile—the Chalk River ZEEP. It is found that the presence of the reflector results in an increase of the mean lifetime  $T$  of about 20%. Increasing the multiplication constant  $k_{\infty}$  by a given amount produces a bigger value of effective multiplication constant  $k_e$  for the pile with a reflector than without, but owing to the larger value of  $T$ , the pile with reflector diverges more slowly than the bare pile. The bare-pile model overestimates by about 10% the change in  $k_{\infty}$  required to re-establish stability after a given change in  $k_e$ . The migration length is overestimated by about 25%. The more elaborate theory agrees well with various measured values, but this is partly fortuitous because the structure of the ZEEP is rather complex and is not adequately represented in the theory. (auth)

## NUCLEAR TRANSFORMATION

5366

STUDY OF PHOTODISINTEGRATION WITH PHOTOGRAPHIC EMULSIONS. III. ( $\gamma, p$ ) REACTION ON COPPER. Raymond Chastel (College of France, Paris). *J. phys. radium* 15, 459-69(1954) June. (In French)

Experiments on the emission of photoprotons from Cu bombarded with 17.6-Mev  $\gamma$  rays are described. The maximum energy of the photoproton spectrum, determined by the path of the protons in an emulsion and using different correction factors, is in good agreement with previous values. The value obtained for the cross section of this reaction is  $(6 \pm 3) \times 10^{-26}$  cm<sup>2</sup>. In line with the discussion of the possibility of emission with a weak probability of other photoparticles, the cross sections of the reactions Cu<sup>65</sup>( $\gamma, d$ ) Ni<sup>63</sup> and Cu<sup>63</sup>( $\gamma, d$ ) Ni<sup>61</sup> were calculated. The calculations were made using the statistical model of Weisskopf for  $\gamma$  energies of 17.6 and 24.6 Mev. The result showed that with the  $\gamma$  radiation used (17.6 Mev) the occurrence of a ( $\gamma, d$ ) reaction has a very low probability. (tr-auth)

5367

STUDY OF THE UTILIZATION OF  $\gamma$  RAYS FROM THE ( $n, \gamma$ ) REACTION CAUSED BY PILE NEUTRONS. V. O. Eriksen and C. P. Zaleski. *J. phys. radium* 15, 492(1954) June. (In French)

The monochromatic  $\gamma$  rays from the ( $n, \gamma$ ) reactions in Fe, Ti, Si, and Cu were used to measure the ( $\gamma, n$ ) cross section of Be. The 7.6-Mev  $\gamma$  rays of Fe gave  $\sigma_{Be(\gamma, n)} = 0.87$  mb; 6.6-Mev  $\gamma$  rays of Ti, 0.94 mb; 5.4 Mev  $\gamma$  rays of S, 0.74 mb; and 7.7-Mev  $\gamma$  rays of Cu, 0.91. (J.S.R.)

5368

SPONTANEOUS FISSION RATE OF <sup>240</sup>Pu. F. R. Barclay, W. Galbraith, K. M. Glover, G. R. Hall, and W. J. Whitehouse (Atomic Energy Research Establishment, Harwell, Berks, England). *Proc. Phys. Soc. (London)* A67, 646-8 (1954) July.

The spontaneous fission rate of Pu<sup>240</sup> was measured with an ionization chamber technique. A value of  $(1.62 \pm 0.04) \times 10^6$  fissions/g/hr was determined. (K.S.)



5369

RADIOCHEMICAL INVESTIGATION OF THE SPONTANEOUS FISSION OF  $\text{Cm}^{242}$ . E. P. Steinberg and L. E. Glendenin (Argonne National Lab., Lemont, Ill.). Phys. Rev. **95**, 431-9(1954) July 15. (cf. NSA 7-3584).

Spontaneous fission of  $\text{Cm}^{242}$  has been investigated by radiochemical determination of the yields of 21 fission products ranging in mass number from 91 to 140. Fission is observed to be asymmetric. The yield-mass curve exhibits somewhat narrower peaks than observed in induced fission and a peak-to-trough ratio of greater than 700 to 1. Prominent fine structure is observed in the mass distribution, and an analysis of this phenomenon is made. The distribution of nuclear charge in spontaneous fission appears to be essentially the same as that in low-energy induced fission. (auth)

5370

INTERACTION OF NEGATIVE MUONS WITH IODINE. Lester Winsberg (Univ. of Chicago). Phys. Rev. **95**, 205-9(1954) July 1.

The interaction of negative muons with iodine was studied radiochemically. The yield of the  $\text{I}^{127}(\mu^-, \nu)\text{Te}^{127}$  reaction was determined to be  $8.2 \pm 1.6$  percent. The sum of the yields of all antimony isotopes is approximately 1 percent. From the yield of 58-day  $\text{Te}^{123m}$  and upper limits to the yields of 104-day  $\text{Te}^{123m}$  and 6-day  $\text{Te}^{118}$ , yield distribution curves were drawn to fit the extremes of the experimental errors. The multiplicity was thus determined to be  $1.7 \pm 0.4$  neutrons per muon capture. A yield distribution curve which best fits the data is presented. (auth)

5371

RADIOCHEMICAL EVIDENCE FOR THE  $\text{Cu}^{65}(\text{p}, \text{p}\pi^+)\text{Ni}^{65}$  REACTION. Si-Chang Fung and Anthony Turkevich (Univ. of Chicago). Phys. Rev. **95**, 176-8(1954) July 1.

A study of the formation of the radioactive nickel isotopes in the irradiation of copper foil with high-energy protons has shown the presence of 2.56-hr  $\text{Ni}^{65}$ . The energy dependence of the cross section for the formation of this species, and its recoil properties, indicate that it is formed by the  $\text{Cu}^{65}(\text{p}, \text{p}\pi^+)\text{Ni}^{65}$  reaction. (auth)

## PARTICLE ACCELERATORS

5372

[European Council for Nuclear Research]  
ENERGY-SPREAD AND PHASE-FOCUSING IN PARTICLE ACCELERATORS. H. G. Hereward. June 1954. 18p. (CERN/PS/HGH/1)

The product of energy spread and time spread associated with the phase oscillations is invariant under certain conditions, which are examined. For rapid or discontinuous variations of parameters this invariance is no longer valid, but there are simple expressions for its increase. Thus, quantities like the energy spread at output or the phase oscillation amplitude at any point can be calculated, and the conditions for keeping such quantities small can be obtained, without detailed orbit calculations. (auth)

5373

Ames Lab.  
AN ELECTRON INJECTOR FOR A 70 MEV SYNCHROTRON. A. J. Bureau, H. A. Austrheim, and D. J. Zaffarano. June 15, 1954. 11p. Contract W-7405-eng-82. (ISC-490)

An electron injector suitable for use in an electron synchrotron or betatron is described. The principal novel feature is that the perishable part of the injector, the filament assembly, can be quickly replaced and adjusted by opening three small stainless steel collets. The injector frame is durably constructed of Mycalex and stainless steel tubing, and experimental electron emitting structures may easily be mounted on it. (auth)

5374

Livermore Research Lab., Calif. Research and Development Co.

DETERMINATION OF POSSIBLE INDUCED ACTIVITY IN MARK I MTA LINEAR ACCELERATOR. G. A. Blanc. May 1954. 17p. Contract AT(11-1)-74. (LRL-116)

Following completion of the experimental operation of the Mark I Linear Accelerator, a radiation survey was made to determine the amount of induced activity in its copper radiofrequency (rf) liner, copper drift tubes, steel vacuum vessel, and associated equipment. The survey included tests employing portable instruments, film studies, and chemical analyses. The drift tubes, the east head of the steel vessel, and the equipment attached to the east head were found to contain varying amounts of induced activity and were not released for salvage. The remainder of the vessel and liner was shown to be free from any induced activity and was made available for salvage. (auth)

5375

[Australian National Univ. Research School of Physical Sciences]

THE CANBERRA AIR-CORED PROTON SYNCHROTRON. May 25, 1954. 14p. (NP-5240)

The design of the proposed Canberra 11-Bev proton synchrotron using an air-cored magnet supplied by a homopolar generator is described. The magnet will be in the form of a race track with 4 quadrants of 480cm mean radius and 4 straights of 2m length. An acceleration period of 0.8 sec will be used with a repetition period of 15 min. (J.A.G.)

5376

CONSIDERATIONS FOR A RADIATION SHIELD FOR A 25 BEV PROTON SYNCHROTRON. A. Citron, W. Gentner, and A. Sittkus (Universität Freiburg i. Br., Germany). Strahlentherapie **94**, 23-8(1954). (In German)

In estimating the necessary dimensions of the shield for the CERN 25-bev accelerator at Geneva, data from cosmic radiation were used. Particular use was made of measurements of neutron absorption in the atmosphere and of observations on nuclear plates of the interaction of high-energy particles. The tolerance flux of fast neutrons, the most dangerous component, was discussed. It was found that a thickness of 5.5 m of concrete is required in the vicinity of the accelerating tube. (J.S.R.)

## RADIATION ABSORPTION AND SCATTERING

5377

Los Alamos Scientific Lab.  
NUCLEAR SCATTERING OF HIGH ENERGY NEUTRONS AND THE OPTICAL MODEL OF THE NUCLEUS (thesis). Theodore Brewster Taylor. June 1954. 60p. Contract [W-7405-eng-36]. (AECU-2916)

The energy dependence of nuclear total cross sections for high-energy neutrons is investigated by means of the optical model. In this analysis, nuclei are represented by spheres of radius  $R$  within which there exists a potential  $V$  and a neutron absorption coefficient  $K$ . It is found that values of  $R$ ,  $V$ , and  $K$  exist which vary smoothly with the energy of incident neutrons in such a way as to give good agreement between calculated and observed cross sections for high-energy reactions. The results of this study give  $R = 1.37A^{1/3}$ ,  $V = 30$  Mev, and  $K = 2.2 \times 10^{12}/\text{cm}$ , and are compared with the work of other investigators. (K.S.)

5378

Brookhaven National Lab.  
THE INELASTIC SCATTERING CROSS SECTION OF LEAD. Sophie Oleksa. Dec. 1953. 15p. (BNL-273)

Calculations of the inelastic scattering cross sections of  $\text{Pb}^{208}$  and  $\text{Pb}^{207}$  at neutron energies of 0.75, 1, 1.5, and 2.05 Mev, using the method of Feshbach, Feld, and colleagues (NYO-636, Phys. Rev. **75**, 1115-24(1949), and Phys. Rev.

87, 366-73(1952)), are presented. The results were multiplied by the respective isotopic abundances, and weighted values are given. The calculations were limited to values of 1 and  $1' \leq 4$ . (J.A.G.)

5379

Knolls Atomic Power Lab.

A STUDY OF NEUTRON CAPTURE IN SAMARIUM, TANTALUM, GOLD, MOLYBDENUM, AND GADOLINIUM, AND TRANSMISSION OF MANGANESE, COBALT, COPPER, AND ZINC WITH THE KAPL BETATRON NEUTRON VELOCITY SELECTOR. E. R. Gaertner, M. L. Yeater, and R. D. Albert. Mar. 15, 1954. 54p. Contract W-31-109-Eng-52. (KAPL-1084)

The experimental results of capture measurements and total cross section measurements with the 100-Mev betatron neutron time-of-flight spectrometer are presented. Capture measurements to determine level densities were made for five elements, samarium, tantalum, gold, molybdenum, and gadolinium, in the energy range of about 10 to 200 ev. An analysis of the procedure for obtaining level parameters from those data is given and is applied in the case of tantalum. Preliminary total cross section measurements were made with a new type of detector ( $n, \gamma$ ) and are given for four elements, manganese, cobalt, copper, and zinc, in the energy range of about 100 to 10,000 ev. The spectrometer is briefly described. (auth)

5380

Los Alamos Scientific Lab.

SURVEY OF AVERAGE NEUTRON TOTAL CROSS SECTIONS FROM 3 TO 13 MEV. Norris G. Nereson, Sperry Darden, Edwin Fryer, Edward T. Journey, Owen Merrill, and Munson M. Thorpe. Apr. 1944. 21p. Contract W-7405-eng-36. (LA-1655)

Neutron total cross sections of 41 elements have been measured over the 3 to 13 Mev energy region. The data are averaged over an energy interval of 10 per cent of the neutron energy and the overall accuracy of the measurements is about  $\pm 10$  per cent. In addition to showing cross sections as a function of energy, the combined results illustrate cross section trends as a function of atomic weight over most of the periodic table. (auth)

5381

Radiation Lab., Univ. of Calif., Berkeley

HIGH ENERGY (d,p) REACTIONS (thesis). Louis Maurice Slater. Mar. 1954. 80p. Contract W-7405-eng-48. (UCRL-2441)

Excitation functions for the (d,p) reaction on  $U^{238}$  and  $Th^{232}$  and for the (d,n) reactions on  $Th^{232}$  have been run in the energy range of the deuterons of the Berkeley 60-inch cyclotron. Excitation functions for the (d,p) reaction on  $U^{238}$ ,  $Th^{232}$ ,  $Pt^{198}$ ,  $Pd^{110}$ ,  $Zr^{90}$ , and  $Mn^{55}$  have also been run in the energy range of the deuterons of the Berkeley 184-inch cyclotron. The experimentally observed high-energy (d,p) excitation functions all exhibit remarkably similar absolute cross-section values. Calculations were made to determine available vacancies for neutron capture to bound levels corresponding to those of a "particle in a box." A spherical potential well was assumed for the nucleus with dimensions corresponding to those calculated for the various nuclei studied. The number of available neutron vacancies was shown to be similar for all of the nuclei studied, thus lending support to the proposed model. Additional support for the model was furnished by the experimentally observed greater cross-section values for the formation of  $Pd^{111g}$  than for the formation of higher spin valued  $Pd^{111m}$  in the (d,p) reaction on  $Pd^{110}$ . It was shown that previous work on the high energy  $Bi^{209}(d,p)Bi^{210}$  excitation function was not at variance with the proposed model; in fact, lower cross-section values for the formation of  $Bi^{210}$  than for the isotopes studied here were to be expected. (auth)

5382

Radiation Lab., Univ. of Calif., Berkeley

A CLOUD-CHAMBER STUDY OF THE SCATTERING CROSS SECTION OF PROTONS BY 90-MEV NEUTRONS AT EXTREME ANGLES (thesis). Chug Ying Chih. May 1954. 43p. Contract W-7405-eng-48. (UCRL-2575)

An investigation of 90-Mev neutrons scattered by protons has been conducted with a cloud chamber filled with hydrogen or with a mixture of methane and hydrogen in a magnetic field of 22,000 gauss. The neutron energy spectrum has a full width at half maximum of about 30 Mev. The neutron scattering angles range from 8 to  $180^\circ$  in the center-of-mass system. The differential scattering cross section is found to have a symmetry about  $90^\circ$  in the center-of-mass system. Detailed results, with a likely theoretical inference, a discussion of errors, and a description of experimental apparatus and procedure, are also presented. (auth)

5383

L-SHELL IONIZATION BY PROTONS OF 1.5- TO 4.25-MEV ENERGY. E. M. Bernstein and H. W. Lewis (Duke Univ., Durham, N. C.). *Phys. Rev.* 95, 83-6(1954) July 1.

Characteristic L-shell x rays produced when protons of 1.5- to 4.25-Mev energy are stopped in Ta, Au, Pb, and U have been studied with a NaI scintillator. The absolute cross sections for x-ray production are presented. By correcting these values for Auger transitions, the L-shell ionization cross sections have been determined. At 3 Mev, the x-ray production cross sections are 104, 74, 54, and 24 barns for Ta, Au, Pb, and U, respectively. (auth)

5384

THERMAL NEUTRON CAPTURE CROSS SECTION OF CARBON-13. G. R. Hennig (Argonne National Lab., Lemont, Ill.). *Phys. Rev.* 95, 92-5(1954) July 1.

The thermal neutron capture cross section of  $C^{13}$  has been determined from the amount of  $C^{14}$  formed in pile-irradiated samples of graphite, barium carbonate, and carbon dioxide. Because of the impurity reaction,  $N^{14}(n,p)C^{14}$ , of comparatively high cross section, the results were consistent only when samples were used which were enriched in  $C^{13}$ . The average isotopic cross section determined for the enriched samples was  $1.4 \pm 0.2$  millibarns. The final value of the cross section in these samples corrected for the estimated residual nitrogen impurity is  $0.9 \pm 0.2$  millibarn. (auth)

5385

GAMMA RADIATION FROM MAGNESIUM-26 UNDER

PROTON BOMBARDMENT. Leonard N. Russell, Warren E. Taylor, and John N. Cooper (Ohio State Univ., Columbus). *Phys. Rev.* 95, 99-101(1954) July 1.

Thin targets of  $Mg^{26}$  were bombarded with protons from a Van de Graaff generator. Fifteen well-defined resonance peaks were found in the proton energy region between 300 and 1500 kev. These resonances were attributed to the reaction  $Mg^{26}(p,\gamma)Al^{27}$ . The maxima of the resonances occur at proton energies of 343, 450, 662, 720, 813, 840, 954, 992, 1015, 1056, 1172, 1255, 1295, 1425, and 1464 kev. Measurement of the gamma-ray energies from some of the stronger resonances indicate that the compound nuclei do not in most cases decay to the ground state by a single transition. (auth)

5386

CAPTURE OF POLARIZED NEUTRONS BY POLARIZED  $Sm^{149}$  NUCLEI. L. D. Roberts, S. Bernstein, J. W. T. Dabbs, and C. P. Stanford (Oak Ridge National Lab., Tenn.). *Phys. Rev.* 95, 105-10(1954) July 1.

The  $Sm^{149}$  nuclei in the paramagnetic salt, samarium ethyl sulfate, were polarized by use of the hyperfine structure coupling, which was known to be large from paramagnetic resonance measurements. The Sm salt was placed in a field of 11,000 gauss after being cooled by thermal contact



with a sample of iron ammonium alum which was demagnetized to zero field from 15,500 gauss and 1.2°K. The nuclear polarization was observed and measured by observations on the state of polarization of the neutrons transmitted by the Sm sample. A single crystal of magnetized magnetite, set to reflect neutrons of 0.07 ev in first order from the 220 planes was used as the analyzer. A nuclear polarization of about 0.12 was deduced from the data. The observed polarization direction of the transmitted neutrons gives  $J = I + \frac{1}{2}$  for the 0.094-ev resonance level in Sm<sup>149</sup>. A temperature of about 0.13°K for the Sm-containing salt was deduced from the observed neutron polarization. (auth)

5387

#### ANGULAR DISTRIBUTION AND CROSS SECTION OF $\text{Li}^6(n,\alpha)\text{H}^3$ FOR NEUTRONS OF 1.1, 1.5, AND 2.0 MEV.

James B. Weddell and James H. Roberts (Northwestern Univ., Evanston, Ill.). *Phys. Rev.* **95**, 117-20(1954) July 1.

The angular distribution of  $\text{Li}^6(n,\alpha)\text{H}^3$  has been determined for 1.1, 1.5, and 2.0 Mev neutrons by track measurements in 100-micron Ilford C2 and E1 lithium-six loaded emulsions. The triton yield function has been expressed as a finite series of spherical harmonics in the center-of-mass system. The s and p components of the neutron wave appear to predominate in the reaction, but the data are not sufficiently accurate to exclude the possibility of contributions from higher angular momentum components. That cross section was also determined for the reaction at neutron energies of 1.5 and 2.0 Mev relative to that at 0.60 Mev. This was done by exposing the same plate to 0.60-, and to 1.5- or 2.0-Mev neutrons; a long counter was used to measure the neutron flux at each energy. Tracks were selected in a suitable cone so as to resolve the two energy groups. The results were  $0.32 \pm 0.06$  and  $0.27 \pm 0.04$  barn at 1.5 and 2.0 Mev, respectively. (auth)

5388

#### 400-MEV NEUTRON-PROTON SCATTERING. A. J. Hartzler and R. T. Siegel (Carnegie Inst. of Tech., Pittsburgh, Penna.). *Phys. Rev.* **95**, 185-92(1954) July 1.

The angular distribution of neutron-proton scattering has been measured at a neutron energy of 400 Mev, with energy resolution of 7 percent. The counter telescope used to detect recoil protons was calibrated in an auxiliary experiment which also gave information about proton-proton scattering at several energies in the 400-Mev region. The n-p cross section has the same general characteristics observed at lower energies, with a minimum at about 100° (c.m. neutron scattering angle) and a large exchange peak at 180°. The p-p results indicate an isotropic cross section below 400 Mev, and a rise at small angles at 428 Mev. (auth)

5389

#### COMPTON SCATTERING. W. B. Cheston (Univ. of Minnesota, Minneapolis). *Phys. Rev.* **95**, 247-8(1954) July 1.

The canonical transformation of Bloch and Nordsieck is used to examine the infrared divergences present in double Compton scattering and radiative corrections to single Compton scattering. (auth)

5390

#### CORRELATIONS IN SPACE AND TIME AND BORN APPROXIMATION SCATTERING IN SYSTEMS OF INTERACTING PARTICLES. Léon Van Hove (Inst. for Advanced Study, Princeton, N. J.). *Phys. Rev.* **95**, 249-62(1954) July 1.

A natural time-dependent generalization is given for the well-known pair distribution function  $g(r)$  of systems of interacting particles. The pair distribution in space and time thus defined, denoted by  $G(r,t)$ , gives rise to a very simple and entirely general expression for the angular and energy distribution of Born approximation scattering by the system. This expression is the natural extension of the familiar Zernike-Prins formula to scattering in

which the energy transfers are not negligible compared to the energy of the scattered particle. It is therefore of particular interest for scattering of slow neutrons by general systems of interacting particles:  $G$  is then the proper function in terms of which to analyze the scattering data. After defining the  $G$  function and expressing the Born approximation scattering formula in terms of it, the paper studies its general properties and indicates its role for neutron scattering. The qualitative behavior of  $G$  for liquids and dense gases is then described and the long-range part exhibited by the function near the critical point is calculated. The explicit expression of  $G$  for crystals and for ideal quantum gases is briefly derived and discussed. (auth)

5391

#### IMPROVED CALCULATION OF THE P-WAVE PION-NUCLEON SCATTERING PHASE SHIFTS IN THE CUT-OFF THEORY. Geoffrey F. Chew (Univ. of Illinois, Urbana). *Phys. Rev.* **95**, 285-6(1954) July 1.

A previously reported perturbation method for evaluating the cut-off form of the Yukawa theory (*Phys. Rev.* **94**, 1755 (1954)) is modified to include the recently established resonance in the state of isotopic spin  $\frac{3}{2}$  and a total angular momentum  $\frac{3}{2}$ . Higher order effects involving the nucleon propagation function are also included. (K.S.)

5392

#### NUMERICAL CALCULATION OF $\frac{3}{2}-\frac{3}{2}$ PION-NUCLEON REACTION MATRIX AND PHASE SHIFTS. Freda F. Salzman and James N. Snyder (Univ. of Illinois, Urbana). *Phys. Rev.* **95**, 286-7(1954) July 1.

A numerical calculation of the Fredholm integral equation connected with the pion-nucleon scattering matrix derived in the previous letter is performed. Numerical solutions were obtained for  $\alpha = (\frac{3}{2}, \frac{3}{2})$ ,  $t^2 = 0.058$ , and  $\omega = 5.6 \mu$ . (K.S.)

5393

#### BACKSCATTERING OF KILOVOLT ELECTRONS FROM SOLIDS. Ernest J. Sternglass (Cornell Univ., Ithaca, N. Y.). *Phys. Rev.* **95**, 345-58(1954) July 15.

The total number and energy distribution of backscattered electrons at 0.2-4 kev incident energy ( $V$ ) have been measured for six elements using electrostatic retarding potential techniques. For atomic number  $Z \lesssim 30$ , backscattering was found to be essentially independent of  $V$  and almost linearly dependent on  $Z$ . For  $Z \gtrsim 30$ , backscattering decreases with decreasing  $V$  below 2-3 kev to values less than those for elements of  $Z \approx 30$ , and it no longer is a simple function of  $Z$ . The ratio of the mean energy of the backscattered electrons to that of the primaries is found to be close to one-half for  $Z = 6$  and to increase only slightly for the heavier elements. These results are shown to indicate a dominant role of inelastic processes in the scattering of intermediate energy electrons, in contrast to scattering at very high energies, where elastic interactions control the phenomenon. (auth)

5394

#### GAMMA-RAY ABSORPTION COEFFICIENTS FOR NaI, Cu, Ta, AND W. P. R. Howland and W. E. Kreger (U. S. Naval Radiological Defense Lab., San Francisco, Calif.). *Phys. Rev.* **95**, 407-10(1954) July 15.

Gamma-ray absorption coefficients have been measured over a range of energies from 0.279 Mev through 1.113 Mev for NaI, Cu, Ta, and W, using an energy-selective scintillation detector. Measurements were made for the absorber position which gave the maximum coefficient, and the results are in good agreement with theory. (auth)

5395

#### YIELD AND ANGULAR DISTRIBUTION OF PROTONS FROM $\text{Li}^6(d,p)\text{Li}^7$ . William E. Nickell (State Univ. of Iowa, Iowa

City). *Phys. Rev.* **95**, 426-30(1954) July 15.

The relative yields versus energy of protons from the reactions  $\text{Li}^6(\text{d},\text{p})\text{Li}^7$ ,  $\text{Li}^7$  have been measured for deuteron energies up to 3.0 Mev. A marked difference in the energy dependence of the yields for the two reactions is noted. The yield for the reaction  $\text{Li}^6(\text{d},\text{p})\text{Li}^7$  shows a broad maximum centered about 1.1-Mev deuteron energy, whereas the yield from the  $\text{Li}^6(\text{d},\text{p})\text{Li}^{7*}$  reaction shows a slow increase throughout the whole energy range covered. Above 2.5 Mev the yield from  $\text{Li}^6(\text{d},\text{p})\text{Li}^{7*}$  exceeds the yield from  $\text{Li}^6(\text{d},\text{p})\text{Li}^7$ . The angular distributions of the two proton groups have been observed at 0.825, 2.0, and 3.0 Mev. The angular distributions of the two groups are quite similar at all energies covered. The Butler analysis of the angular distribution data indicates that in both reactions the neutron is captured with one unit of orbital angular momentum. Since  $\text{Li}^6$  has even parity and spin 1, this gives odd parity for the ground state and the first excited state of  $\text{Li}^7$  and possible values of  $1/2$ ,  $3/2$ , and  $5/2$  for the spins of the ground state and the first excited state. These possible values include the known spin of  $3/2$  for the ground state and the currently accepted spin of  $1/2$  for the first excited state. (auth)

5395

**GAMMA RADIATION FROM REACTIONS INDUCED BY POLARIZED PARTICLES.** J. M. Kennedy and W. T. Sharp (Atomic Energy of Canada Ltd., Chalk River, Ontario). *Phys. Rev.* **95**, 440(1954) July 15.

The formulas of Simon which involve gamma radiation have been simplified by carrying out sums over parameters that do not represent observed properties of the radiation.

5397

**STOPPING POWER OF ORGANIC FOILS FOR 6 MEV ALPHAS.** John Phelps, W. F. Huebner, and Franklin Hutchinson (Yale Univ., New Haven, Conn.). *Phys. Rev.* **95**, 441-4(1954) July 15.

The stopping power of several thin organic foils has been measured relative to air at 6 Mev. A simple cut-off method provided a direct comparison with air using natural alphas from  $\text{Po}^{212}$ . Mean atomic stopping powers relative to air are: polythene, 0.422; polyvinyl alcohol, 0.515; cellulose acetate, 0.617; regenerated cellulose, 0.597; Mylar, 0.627. Values are also given for the mg per  $\text{cm}^2$  of each foil equivalent in stopping power to one cm of air. The experimental stopping powers are reproducible to within two percent and average about three percent below values calculated using the additive law and mean excitation potentials for H, C, N, and O taken from the literature. (auth)

5398

**EUROPIUM ACTIVATION STUDIES WITH MONOCHROMATIC NEUTRONS.** R. E. Wood (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **95**, 453-5(1954) July 15.

Resonances in the europium slow neutron cross section at  $-0.011$ ,  $+0.327$ ,  $0.461$ ,  $1.055$ ,  $2.74$ ,  $3.35$ , and  $7.36$  ev have been assigned to  $\text{Eu}^{151}$ . This was done by observing the intensity of the 9.3-hour activity of  $\text{Eu}^{152}$  produced as a function of neutron energy. The remainder of the europium resonances below 10 ev were assumed to be due to  $\text{Eu}^{153}$ ; i.e.,  $1.76$ ,  $2.47$ ,  $3.84$ ,  $6.25$ , and  $8.98$  ev. The fraction of the compound nuclei decaying to the isomeric state of  $\text{Eu}^{152}$  was found to vary by a factor of four for different resonances in  $\text{Eu}^{151}$ . These fractions were obtained for six of the seven resonances in  $\text{Eu}^{151}$ . (auth)

5999

**THE DIRECTIONAL CORRELATION OF THE  $\gamma$  RAYS OF  $\text{A}^{38}$ .** J. J. Kraushaar, J. W. Mihelich, and A. W. Sunyar (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **95**, 456-7(1954) July 15.

The angular correlation of the  $\gamma$  rays in  $\text{A}^{38}$  following the  $\beta$ -decay of  $\text{Cl}^{38}$  has been measured. The correlation function is in agreement with that expected for the spin sequence  $3(\text{D})2(\text{Q})0$  or possible  $1(\text{D},\text{Q})2(\text{Q})0$  with a 2.5 percent quadrupole intensity (out of phase). Gamma-ray lifetime arguments strongly favor the  $3-2-0$  spin sequence. (auth)

5400

**FINE STRUCTURE IN THE  $\text{C}^{12}(\gamma,\text{n})\text{C}^{11}$  AND  $\text{O}^{16}(\gamma,\text{n})\text{O}^{15}$  ACTIVATION CURVES.** L. Katz, R. N. H. Haslam, R. J. Horsley, A. G. W. Cameron, and R. Montalbetti (Univ. of Saskatchewan, Saskatoon, Canada). *Phys. Rev.* **95**, 464-71(1954) July 15.

A careful examination of the  $\text{C}^{12}(\gamma,\text{n})\text{C}^{11}$  and  $\text{O}^{16}(\gamma,\text{n})\text{O}^{15}$  reactions, resulting from irradiating samples with betatron bremsstrahlung, has revealed discontinuities in the yields as a function of peak bremsstrahlung energy. These discontinuities are interpreted to indicate the presence of strong photon absorption levels in the  $\text{C}^{12}$  and  $\text{O}^{16}$  nuclei. In  $\text{C}^{12}$  the discontinuities were found at 19.3, 19.8, 20.1, 20.5, 20.7, 21.1, 21.6, 22.4, and 22.8 Mev, and in  $\text{O}^{16}$  they were found at 15.9, 16.4, 16.7, 16.9, 17.1, 18.9, 19.3, 20.7, and 21.9 Mev. The experimental results are discussed in detail and are interpreted qualitatively. (auth)

5401

**FINE STRUCTURE IN THE NEUTRON YIELD CURVES FROM  $(\gamma,\text{n})$  REACTIONS IN  $\text{Li}^7$ ,  $\text{C}^{12}$ ,  $\text{O}^{16}$ , AND  $\text{F}^{19}$ .** J. Goldemberg and L. Katz (Univ. of Saskatchewan, Saskatoon, Canada). *Phys. Rev.* **95**, 471-5(1954) July 15.

Fine structure previously observed in the  $\beta^+$  activation curves of  $\text{C}^{11}$  and  $\text{O}^{15}$  resulting from the betatron induced reactions  $\text{C}^{12}(\gamma,\text{n})\text{C}^{11}$  and  $\text{O}^{16}(\gamma,\text{n})\text{O}^{15}$  is shown to be present in the neutron yield curves from these reactions by detecting the emitted neutrons. The position of this fine structure as a function of betatron operating energy is the same in both cases to within experimental accuracy. The  $\text{Li}^7(\gamma,\text{n})\text{Li}^6$  and  $\text{F}^{19}(\gamma,\text{n})\text{F}^{18}$  were examined and discontinuities in the neutron yield curves were found at 9.6, 10.8, 12.4, 14.0, and 17.5 Mev for the first reaction and 11.0, 11.5, 11.9, and 15.3 for the second. (auth)

5402

**HIGH-ENERGY ELECTRON SCATTERING AND NUCLEAR STRUCTURE DETERMINATIONS. II.** R. Hofstadter, B. Hahn, A. W. Knudsen, and J. A. McIntyre (Stanford Univ., Calif.). *Phys. Rev.* **95**, 512-15(1954) July 15. (cf. NSA 7-6206).

Elastic scattering measurements have been carried out with electrons in  $\text{Au}^{197}$  at energies of 84, 126, 154, and 183 Mev and in  $\text{Pb}^{208}$  at 84, 153, and 186 Mev. Diffraction effects are observed which appear to vary with momentum and angular position as if a fundamental parameter  $p \sin(\theta/2)$  were equal to a constant for a given diffraction feature. Such a behavior would be predicted by the Born approximation. A comparison of the scattering in  $\text{Au}^{197}$  and  $\text{Pb}^{208}$  suggests that inelastic scattering does not materially influence the scattering curves presented. The appearance of diffraction effects indicates a model more nearly uniform in charge density than early tentative conclusions based on Born approximation calculations. (auth)

5403

**POLARIZATION IN HIGH-ENERGY ELASTIC NUCLEON-NUCLEUS SCATTERING.** Bertram J. Malenka (Harvard Univ., Cambridge, Mass.). *Phys. Rev.* **95**, 522-6(1954) July 15.

The proposal to explain the comparatively large polarization observed in high-energy elastic proton-nucleus scattering by means of the spin-orbit interaction used in the shell model of the nucleus is examined.



Three simple examples are considered in first Born approximation. The approximate magnitude and the approximate location of the maximum polarization for 340-Mev nucleons on carbon is in rough agreement with experiment. However, regions of negative polarization also seem to be predicted by the theory. Finally, an approximate method to calculate the polarization for high energy and small scattering angle is suggested. (auth)

5404

ON THE CAPTURE OF  $\mu^-$  MESONS BY LIGHT NUCLEI. A. Alberigi Quaranta and E. Pancini (Univ. of Rome and Genova Istituto Nazionale di Fisica Nucleare—Sezione di Roma). Nuovo cimento (9) 11, 607-17(1954) June. (In Italian).

An experiment is described to test the validity of Wheeler's law for the Z dependence of the probability of capture of negative  $\mu$  mesons by light nuclei ( $Z \leq 26$ ). With an apparatus described in a preceding paper, the apparent mean life of the  $\mu$  mesons  $\tau^-$  has been measured in Al and S, with the result  $\tau^- = 1.02 \pm 0.04$  in Al and  $\tau^- = 0.70 \pm 0.04$  in S. Using these values, those obtained previously for C, and a value obtained by Keuffel et al. for Fe, it is concluded that Wheeler's theory is sufficient to explain, within the limits of accuracy at present attainable, the dependence on Z of the capture probability  $p_c$  in light nuclei ( $Z \leq 26$ ). The values  $k = 4.4 \pm 0.3$  and  $Z_0 = 11.3$  are found for the constants introduced by Wheeler in the law  $p_c = (1/\tau_0)(Z/Z_0)^R$ . (auth)

5405

INFLUENCE OF MULTIPLE SCATTERING ON BREMSSTRAHLUNG EMISSION AT HIGH ENERGIES. A. B. Migdal. Doklady Akad. Nauk S.S.S.R. 96, 49-52(1954) May 1. (In Russian)

A quantitative examination of the problem of bremsstrahlung emission, during which the electron energy is limited only by the condition  $E \gg mc^2$ , is presented. It is shown that for the emission of quanta with energy much less than the energy of the electrons classic mechanics and the classic theory of emission can be used. (J.S.R.)

5406

ON ENERGY SCATTERING IN THE SPECTRUM OF X-RAY BREMSSTRAHLUNG. R. Fuchs and H. Kulenkampff (Physikalisches Institut der Universität, Würzburg, Germany). Z. Physik 137, 583-7(1954) June. (In German).

Earlier measurements by Kulenkampff and Schmidt give approximately, for the spectrum of the x-ray bremsstrahlung of a massive W anticathode in the range of 20 to 50 kv, the simple form  $J\nu = \text{const.} \times (\nu_k - \nu)$ . These measurements were repeated, and an additional correction for the frequency dependence of the reflection capacity of the spectrometer crystal was inserted. The simple regularity is lost. It was again restored by accidental equalization when the radiation portion of the electron lost by re-diffusion was added. It is indicated that the simple form is not generally valid. (tr-auth)

5407

RESONANT SCATTERING OF GAMMA-RAYS IN  $^{63}\text{Cu}$  AND  $^{56}\text{Fe}$ . K. Ilakovac (Univ. of Birmingham, England). Proc. Phys. Soc. (London) A67, 601-7(1954) July.

The 0.96 Mev gamma radiation following the decay of  $^{63}\text{Zn}$  is selectively scattered by copper. The intensity of elastic scattering from copper at  $90^\circ$  is several times greater than from iron, provided that the  $^{63}\text{Zn}$  source is in solution; with a solid source, only slight evidence of resonant scattering has been found. These results are interpreted as resonant nuclear scattering by  $^{63}\text{Cu}$ , and are analysed in terms of the displacement and broadening of the emission line by nuclear recoil, which persists longer in the liquid than in the solid. The mean life of the 0.96-Mev excited state of  $^{63}\text{Cu}$  is estimated to be of the order of

$6 \times 10^{-12}$  second. From the absence of any observable selective scattering by iron of the gamma-rays following the decay of  $^{56}\text{Mn}$ , the mean life of the 0.84-Mev excited state of  $^{56}\text{Fe}$  is estimated to exceed  $8 \times 10^{-12}$  second. (auth)

5408

REDUCED WIDTHS FROM (d,p) REACTIONS. Yoichi Fujimoto (Kyoto Univ., Japan), Ken Kikuchi (Osaka Univ., Japan), and Shiro Yoshida (Kyoto Univ., Japan). Progr. Theoret. Phys. (Japan) 11, 264-72(1954) March.

Reduced widths of low-lying levels are calculated from experimental deuteron stripping cross sections on the basis of Butler theory. The validity of the approximation is examined by these reduced widths. The structure of low-lying levels is discussed from our results. (auth)

5409

ON AN EXPRESSION FOR THE TOTAL CROSS SECTION. L. I. Schiff (Stanford Univ., Stanford, California). Progr. Theoret. Phys. (Japan) 11, 288-90(1954) March.

The well-known expression for the total cross section in terms of the imaginary part of the coherent forward scattered amplitude is derived in a simple and general way from wave theory. The derivation also shows that there is a "shadow remnant" beyond the actual shadow, within which the forward coherent scattering intensity is diminished, of approximate radius  $(r|k|)^{1/2}$ , where r is the distance from the scattering center and  $k = 2\pi/\lambda$  is the wave number. A qualitative understanding of the shadow remnant is obtained in terms of the uncertainty principle. (auth)

5410

ON THE NEUTRON  $\text{He}^4$  SCATTERING. Taro Tamura (Tokyo Univ. of Education, Japan). Progr. Theoret. Phys. (Japan) 11, 335-6(1954) Mar.

## RADIATION EFFECTS

5411

Knolls Atomic Power Lab.  
ELECTRON IRRADIATION OF SILICON p-n JUNCTIONS. J. W. Moyer. May 21, 1954. 19p. Contract W-31-109-Eng-52. (KAPL-1146)

Measurements of the current, voltage, and power generation due to electron-hole pair production by high-energy electrons were made on two silicon p-n junctions. The electrons were accelerated to a peak of 800 kev, although the average energy was 500 kev. The efficiency of the process was observed to increase with the incident beam intensity as predicted for the photovoltaic effect. (auth)

5412

SOME EFFECTS OF NEUTRON IRRADIATION OF DIAMOND. A. H. Benny and F. C. Champion (King's Coll., London). Nature 173, 1087(1954) June 5.

Fine type 2 diamonds were irradiated by neutrons in BEPO at Harwell. The  $\alpha$  counting response and the ultraviolet transmission were progressively reduced with increasing neutron exposure. Some recovery in both those properties took place on heating the specimens. A decrease in the over-all insulation resistance which was at least partially restored by heating was noted also. (A.G.W.)

5413

DECOMPOSITIONS OF INORGANIC SPECIMENS DURING OBSERVATION IN THE ELECTRON MICROSCOPE. Robert B. Fischer (Indiana Univ., Bloomington). J. Appl. Phys. 25, 894-6(1954) July.

Several inorganic substances have been examined by electron microscope and selected area electron diffraction techniques. Large crystals of sodium chloride and potassium chloride break up into many smaller crystals of the same substances. Ammonium chloride evaporates,

and nitron nitrate appears merely to melt. Reduction to metal was found for silver chloride, silver nitrate, lead carbonate, and cupric oxide. Only morphological changes were observed on bombardment of silver sulfate, lead oxide, lead chloride, and gold chloride. Hydrous ferric oxide and aluminum oxide were converted to crystalline forms which could not be identified by electron diffraction. (auth)

# RADIOACTIVITY

5414

THE DISINTEGRATION OF  $\text{Rh}^{102}$ . Luis Marquez (Univ. of Chicago). *Phys. Rev.* **95**, 67-8(1954) July 1.

The disintegration of  $\text{Rh}^{102}$  has been investigated using a beta-ray spectrometer. It was found that it decays by the emission of a negatron of end-point energy of 1150 kev and three positrons of end-point energies of 400 kev, 760 kev, and 1240 kev. Five gamma rays were also found in its disintegration of 86 kev, 124 kev, 195 kev, 353 kev, and 475 kev. (auth)

5415

DECAY SCHEME AND GAMMA-GAMMA CORRELATIONS IN  $\text{B}^{10}$ . S. M. Shafroth and S. S. Hanna (The Johns Hopkins Univ., Baltimore, Md.). *Phys. Rev.* **95**, 86-91(1954) July 1.

Gamma rays from the deuteron bombardment of beryllium were studied with two scintillation spectrometers operated in coincidence. Gamma rays of energies 2.86, 2.15, 1.43, 1.02, 0.72, and 0.41 Mev, which have previously been associated with the  $\text{B}^{10}$  nucleus, were identified in single-channel spectra. Coincidences were observed between the following pairs of gamma rays: 2.86-0.72, 2.15-1.43, 1.43-1.43, 1.43-1.02, 1.43-0.72, 1.43-0.41, 1.02-0.72, 1.02-0.41, and 0.72-0.41. The decay scheme obtained from these measurements agrees with the one proposed by Ajzenberg, except for the presence of an additional 1.43-Mev transition between the 3.58- and 2.15-Mev states of  $\text{B}^{10}$ . A survey was made of the directional angular correlations between several of these coincident radiations. (auth)

5416

DETERMINATION OF MAXIMUM BETA ENERGY IN THE DECAY OF  $\text{P}^{33}$ . B. Elbek, K. O. Nielsen, and O. B. Nielsen (Univ. of Copenhagen, Denmark). *Phys. Rev.* **95**, 96-7(1954) July 1.

The maximum energy of the  $\beta$  spectrum of  $\text{P}^{33}$  has been measured with sources prepared in two different ways. The first source was activated according to the method of Westermarck. The second source was prepared in an isotope separator. The results were  $252 \pm 5$  kev and  $250 \pm 5$  kev, respectively. (auth)

5417

INNER BREMSSTRAHLUNG IN THE ELECTRON CAPTURE PROCESS— $\text{Ge}^{71}$ . Babulal Saraf (Franklin Inst., Swarthmore, Penna.). *Phys. Rev.* **95**, 97-8(1954) July 1.

The spectral distribution of the inner bremsstrahlung of  $\text{Ge}^{71}$  has been studied at quantum energies as low as 20 kev. It was observed that the radiation intensity at energies less than ~100 kev is much larger than is indicated by currently available theory. The absolute radiative capture probability has been measured. This latter quantity and the spectral shape are in good agreement with theoretical considerations at energies greater than ~100 kev. (auth)

5418

DECAY SCHEME OF  $\text{Co}^{56}$ . M. Sakai, J. L. Dick, W. S. Anderson, and J. D. Kurbatov (Ohio State Univ., Columbus). *Phys. Rev.* **95**, 101-4(1954) July 1.

The decay scheme of  $\text{Co}^{56}$  was studied by means of a magnetic lens spectrometer and a gamma-gamma coincidence scintillation spectrometer. The positron spectrum consists of two groups of maximum energies of 1.50 Mev and 0.44 Mev, relative abundance of 96 percent and 4 per-

cent, respectively, leading to a second and third excited state of  $\text{Fe}^{56}$ . Orbital electron capture also takes place involving several other excited states. Both of the beta-ray spectra involved appear to have the "allowed" shape of the Fermi plot. The energies of the gamma rays emitted by the  $\text{Fe}^{56}$  nucleus were determined by studies of the photo-electron spectrum and scintillation spectrum. The energies determined were 0.845 Mev, 1.24 Mev, 1.75 Mev, 2.30 Mev, 2.60 Mev, and 3.25 Mev, respectively. These gamma rays were fitted into the decay scheme by means of beta spectrum analysis and gamma-gamma coincidence experiments. (auth)

5419

BETA-ALPHA CORRELATION IN THE DECAY OF  $\text{Li}^8$ . S. S. Hanna, E. C. LaVier, and C. M. Class (Johns Hopkins Univ., Baltimore, Md.). *Phys. Rev.* **95**, 110-11(1954) July 1.

The beta-alpha directional correlation in the  $\text{Li}^8(\beta)\text{Be}^{8*}(\alpha)\text{He}^4$  decay has been measured for various portions of the upper end of the beta spectrum, from about 90 percent to 10 percent of the total beta spectrum. No significant departure from isotropy was observed at the higher beta energies, as reported in earlier measurements. An average of the measurements gives a value of  $A_2 = 0.01 \pm 0.03$  in the correlation function  $1 + A_2 \cos^2\theta$ . (auth)

5420

SECOND-ORDER CORRECTIONS TO BETA SPECTRA. P. F. Zweifel (Knolls Atomic Power Lab., Schenectady, N. Y.). *Phys. Rev.* **95**, 112(1954) July 1.

The origin of small correction terms to beta spectra is discussed. The second-order corrections to allowed spectra are presented for both pure interactions and linear combinations. (auth)

5421

TECHNETIUM ACTIVITIES AT MASS 97. G. E. Boyd (Oak Ridge National Lab., Tenn.). *Phys. Rev.* **95**, 113-14(1954) July 1.

A technetium activity believed to be  $\text{Tc}^{97g}$  has been observed to decay with molybdenum K x rays and to possess a half life in the range of  $10^4$  to  $10^5$  years. (auth)

5422

FURTHER STUDY OF THE DECAY SCHEME OF  $\text{Ir}^{192}$ . R. W. Pringle, W. Turchinets, and H. W. Taylor (Univ. of Manitoba, Winnipeg, Canada). *Phys. Rev.* **95**, 115-16(1954) July 1.

Scintillation spectrometer studies have revealed four high-energy gamma-ray components at 788, 883, 1080, and 1210 kev, with the possibility of a fifth component near 920 kev. The  $\text{Ir}^{192}$ — $\text{Pt}^{192}$  ground-ground state transition energy has been measured as  $1490 \pm 20$  kev. Level schemes are proposed for  $\text{Pt}^{192}$  and  $\text{Os}^{192}$ , the product nuclei upon the beta decay of  $\text{Ir}^{192}$ . (auth)

5423

DECAY SCHEMES OF  $\text{Cd}^{114}$  AND  $\text{Te}^{125}$ . D. C. Lu, W. H. Kelly, and M. L. Wiedenbeck (Univ. of Michigan, Ann Arbor). *Phys. Rev.* **95**, 121-2(1954) July 1.

Using the scintillation-crystal summing technique, coincidences between the gamma rays of  $\text{Cd}^{114}$  and of  $\text{Te}^{125}$  were studied. In the case of  $\text{Cd}^{114}$  no indications were seen of the existence of a 1.3-Mev and a 576-kev gamma ray previously reported. In the case of  $\text{Te}^{125}$ , the 176-kev gamma ray appeared not to be in coincidence with any other gamma rays. It must, therefore, end in a metastable state or the ground state. (auth)

5424

A  $\beta$ -DECAY MATRIX ELEMENT FOR A DEFORMED CORE MODEL. Martin G. Redlich and Eugene P. Wigner (Princeton Univ., New Jersey). *Phys. Rev.* **95**, 122-6(1954) July 1.

The  $f_t$  value for an allowed unfavored  $\beta$  transition, calculated on a deformed core + single-particle model, is  $\approx 3$  times the single-particle value and about 4 percent of the observed value. The deformations of initial and final states



were based on their quadrupole moments. The calculation indicates that for this model core orthogonality generally does not account for the difference between allowed favored and unfavored  $ft$  values. (auth)

- 5425  
**DISINTEGRATION OF  $I^{128}$ .** M. L. Perlman and Joan P. Welker (Brookhaven National Lab., Upton, N. Y.). *Phys. Rev.* **95**, 133-7(1954) July 1.

The radiations from  $I^{128}$  have been investigated with a scintillation coincidence spectrometer;  $\beta$ - $\gamma$ ,  $\gamma$ - $\gamma$ , and  $x$ - $\gamma$  events were studied. In a fraction of the electron-capture disintegrations, a gamma ray of energy 0.74 Mev was found to occur in cascade with the previously known 0.65-Mev gamma ray. The crossover transition also was observed. In a fraction of the negative beta-decay processes, a gamma ray of energy 0.48 Mev occurs in cascade with the previously known 0.38-Mev gamma ray; in addition, the crossover transition was observed. The maximum energy of the positron spectrum and the relative intensities of all gamma transitions and of the annihilation radiation were measured. The intensity information, combined with the previously measured ratio of electron-capture probability to beta-decay probability and with the ratio of the intensities of the 0.85-Mev and 1.24-Mev beta rays, is sufficient to give the abundances of all observed transitions in the decay scheme. Both the  $ft$  values and the measured ratio of electron-capture probability to positron-emission probability for the ground-state transitions indicate that  $I^{128}$  has spin 2 and negative parity. The shell structure assignments, neutron  $h_{11/2}$  and proton  $g_{7/2}$ , are the only ones which can couple to give the resultant spin 2 and negative parity. (auth)

- 5426  
 **$O^{14}$  DECAY AND THE FERMI COUPLING CONSTANT IN BETA DECAY.** J. B. Gerhart (Princeton Univ., New Jersey). *Phys. Rev.* **95**, 288-9(1954) July 1.
- The positron spectrum of  $O^{14}$  was found to have an allowed shape with end-point energy  $1835 \pm 8$  kev. The half life is  $72.1 \pm 0.4$  sec,  $ft$  is  $3275 \pm 75$  sec, and no evidence for a ground-state transition was found. The equation  $A = ft \left( \int f^2 + R \int \sigma^2 \right)$  is valid,  $A$  is  $6550 \pm 150$  sec and the Fermi coupling constant was directly determined to be  $G_F = 1.374 \pm 0.016 \times 10^{-49}$  erg  $cm^3$ . (K. S.)

- 5427  
**DECAY OF  $Sb^{124}$ .** N. H. Lazar (Oak Ridge National Lab., Tenn.). *Phys. Rev.* **95**, 292-3(1954) July 1.
- A NaI(Tl) scintillation spectrometer was used to investigate the  $\gamma$  spectrum of  $Sb^{124}$ . The data obtained is used to propose a decay scheme. (K.S.)

- 5428  
**DISINTEGRATION OF  $K^{43}$ .** Torsten Lindqvist and Allan C. G. Mitchell (Indiana Univ., Bloomington, Ind.). *Phys. Rev.* **95**, 444-6(1954) July 15.

The nuclear spectrum of  $K^{43}$  (22.0 hr) has been studied with the help of a magnetic lens spectrograph.  $K^{43}$  decays to  $Ca^{43}$ , emitting gamma rays having energies 0.369, 0.627, 0.219, 0.393, and 1.00 Mev, the last three being weak. Five beta-ray groups were found, of energies 1.839, 1.218, 0.927, 0.460, and 0.243 Mev with relative abundance of 1.6, 5.4, 83.1, 5.4, and 4.5 percent, respectively. A disintegration scheme is proposed. The  $K^{43}$  was prepared by the reaction  $A^{46}(\alpha, p)K^{43}$ . (auth)

- 5429  
**MASS DIFFERENCES FOR ISOBARS CAPABLE OF DOUBLE-BETA DECAY.** John T. McCarthy (Western Reserve Univ., Cleveland, Ohio). *Phys. Rev.* **95**, 447-8(1954) July 15.
- A list has been prepared of nuclei with  $A \leq 150$  for which there is a large energy available for double-beta decay. Mass differences were found from experimental data and by calculation with the Wigner formula. In no case is the energy

for double-positron emission as large as 1 Mev. About 2 Mev or more is available for the emission of two negative electrons by  $Ca^{48}$ ,  $Ge^{76}$ ,  $Se^{82}$ ,  $Zr^{96}$ ,  $Mo^{100}$ ,  $Cd^{116}$ ,  $Sn^{124}$ ,  $Te^{130}$ ,  $Xe^{136}$ , and  $Nd^{150}$ . Calculations with the mass formula appear adequate for isobars with  $\Delta Z = 2$  when proper attention is paid to magic-number discontinuities. (auth)

- 5430  
 **$\beta$  SPECTRUM OF  $I^{129}$  AND ITS DECAY SCHEME.** E. der Mateosian (Brookhaven National Lab., Upton N. Y.) and C. S. Wu (Columbia Univ., N. Y.). *Phys. Rev.* **95**, 458-61(1954) July 15.

The decay of  $I^{129}$  has been studied with several instruments including a magnetic lens spectrometer, a scintillation spectrometer utilizing a technique in which the activity is introduced into a NaI(Tl) crystal, and a proportional counter. A soft beta radiation whose end-point value is measured to be  $150 \pm 5$  kev and a gamma radiation of 38 kev are observed. The shape of the beta spectrum is studied and the K-conversion coefficient and the K/L conversion ratio for the 38 kev gamma radiation are determined. The beta and gamma radiations are shown to be in coincidence and an upper limit is set for a possible beta branch to the ground state of  $Xe^{129}$ . Spin assignments are made which agree with shell model theories of the nucleus and with data available on the decay of the 8-day isomer of  $Xe^{129}$ . (auth)

- 5431  
**THEORETICAL ANGULAR CORRELATIONS IN ALLOWED BETA TRANSITIONS.** O. Kofoed-Hansen (Univ. of Copenhagen, Denmark). *Kgl. Danske Videnskab. Selskab Mat.-fys. Medd.* **28**, No. 9, 1-19(1954).

The angular distribution in beta decay is usually expressed in terms of the beta-particle energy and the angle between the directions of emission of the electron and the neutrino. In the present paper, this distribution is transformed into the distribution function for any two of the observable variables, viz. the beta energy, the recoil energy, and the angle between the direction of emission of the recoil and the electron. (auth)

- 5432  
**COMPARISON OF ISOTOPES FOR USE IN MULTI-CURIE THERAPY SOURCES.** N. J. Hopkins (Atomic Energy of Canada Ltd., Ottawa). *Atomics* **5**, 199-204(1954) July.
- With the increasing interest in  $\gamma$ -emitting radioactive isotopes as radiation sources for cancer therapy, it has become important that the problem of selecting the isotope with most favorable characteristics should be carefully re-examined. (auth)

- 5433  
**CONTRIBUTION TO THE STUDY OF THE DECAY SCHEME OF  $Sm^{153}$ .** Nadine Marty. *Compt. rend.* **238**, 2516-18(1954) June 28. (In French).

The relative intensity of the  $\beta_2$  and  $\beta_3$  spectra of maximum energy 690 and 620 kev was found to be 45 and 55%. The intensity of  $\gamma$  rays of 545 kev coincident with that of 103 kev was  $7\% < I_{\gamma^{545}}/I_{\gamma^{103}} < 1\%$ . The existence of a direct transition of 172 kev is confirmed such that  $I_{\gamma^{172}}/I_{\gamma^{103}} < 2\%$ . It is shown that a conversion  $\gamma$  ray of 84 kev corresponds to the  $\gamma$  emitted during the Coulomb excitation of  $Eu^{153}$  (tr-auth)

- 5434  
**ON THE CONTINUOUS  $\gamma$  RADIATION ASSOCIATED WITH K CAPTURE IN  $Ge^{71}$ .** Michel Langevin. *Compt. rend.* **238**, 2518-20(1954) June 28. (In French).

A scintillation spectrometer study of the continuous  $\gamma$  spectrum associated with K capture in  $Ge^{71}$  (11 day) gives an energy of  $237 \pm 5$  kev for the transition. The form of the spectrum as a function of time, as well as a study of the decrease in activity of characteristic x radiation of Ge, shows the presence of a second pure K capture of disintegration energy  $170 \pm 10$  kev. (tr-auth)



5435

STUDY OF  $\gamma$  AND X RADIATIONS EMITTED BY  $\text{Pa}^{231}$ . Adnan Mouhasseb and Michel Riou. *Compt. rend.* **238**, 2520-2(1954) June 28. (In French).

A scintillation counter is used to determine the energies and relative intensities of 27-, 47-, and 295-keV  $\gamma$  radiation and 15- and 95-keV fluorescent x radiation emitted during the transition  $_{81}\text{Pa}^{231} \rightarrow _{81}\text{Ac}^{227}$ . (tr-auth)

5436

RADIATION LOSS IN INTERNAL CONVERSION. K. Baumann and H. Robl (Univ. of Vienna). *Z. Naturforsch.* **9a**, 511-15(1954) June. (In German).

The internal bremsstrahlung from conversion electrons, which were investigated experimentally by Brown and Stump (*Phys. Rev.* **90**, 1061(1953)), is treated theoretically. By a limitation to K electrons an approximation for small nuclear charge number was used. The differential transition probability was indicated both for magnetic and electric multiple transitions of any order. It is shown that the energy and angular distribution of energetic light quanta deviates from the Chang and Falkoff formula only for small radiation losses. A marked maximum is displayed for small nuclear charge numbers. (tr-auth)

5437

ON THE PHOTONS OF CONSECUTIVE REARRANGEMENT WITH AUTOIONIZATION AND THE INTERNAL BREMSSTRAHLUNG SPECTRUM OF THE NUCLIDE  $\text{P}^{32}$ . G. A. Renard (College of France, Paris). *J. phys. radium* **15**, 30-1S(1954) June. (In French)

The photon spectrum of internal bremsstrahlung of  $\text{P}^{32}$  was studied in the range from  $< 1$  to 8 keV. In the first experiment an Al counter and canalizer were used; in a second, a brass counter and a plexiglas canalizer. The spectra from the two experiments are graphed. Both are in agreement with theory. (J.S.R.)

5438

$\alpha$ - $\gamma$  ANGULAR CORRELATIONS IN  $\text{I}_0(\text{Th}^{230})$ . P. Benoist, P. Falk-Vairant, J. Teillac, and G. Valladas (Institut du Radium, Paris). *J. phys. radium* **15**, 32-3S(1954) June. (In French).

For  $\text{Th}^{230}$  the angular correlations  $\alpha_1$ - $\gamma$  (68 keV),  $\alpha_2$ - $\gamma$  (142 keV), and  $\alpha_1$ -L, where L represents the x radiation of rearrangement following internal conversion in the  $\text{L}_{II}$  and  $\text{L}_{III}$  sublevels at 68 keV, were measured. An analysis of the experimental results gave for the 68-keV radiation  $W_1(\theta) = 1 + 0.338P_2(\cos \theta) - 0.969P_4(\cos \theta)$ , for the 142-keV radiation  $W_2(\theta) = 1 + 0.376P_2(\cos \theta) - 0.225P_4(\cos \theta)$ , and for the L radiation,  $W_3(\theta) = 1$ . To obtain the experimental correlation, an attenuation factor was introduced for the Legendre polynomials. The attenuation factor is dependent on the parameter  $\omega\tau$ , where  $\omega \sim Q/J(2J-1)$  and  $\tau$ ,  $Q$  and  $J$  are the average life, the quadrupole moment, and the spin of the intermediate state. In the case of the L radiation, it is shown theoretically that  $\text{L}_{II}$  has no correlation and  $\text{L}_{III}$  has an anisotropy too weak to measure experimentally. (J.S.R.)

5439

INTERNAL BREMSSTRAHLUNG OF  $\text{P}^{32}$  AND  $\text{Y}^{90}$ . A. Michalowicz and R. Bouchez (Institut de Radium, Paris). *J. phys. radium* **15**, 33-4S(1954) June. (In French)

The  $\gamma$  spectra of the internal bremsstrahlung of the permitted  $\beta$  spectrum of  $\text{P}^{32}$  and the forbidden  $\beta$  spectrum of  $\text{Y}^{90}$  were studied. The spectra are in good agreement with theory from the aspect of intensity and form. More precise measurements are needed, however, to fully distinguish between the permitted and forbidden spectra. (J.S.R.)

5440

ON THE FORM OF FORBIDDEN  $\beta$  SPECTRA OF THE FIRST ORDER. Jeanne Laberrigue-Frolow and Roger

Nataf (College of France, Paris). *J. phys. radium* **15**, 438-44(1954) June. (In French)

The correction coefficients with respect to the permitted form of the  $\beta^+$  and  $\beta^-$  spectra were calculated for the forbidden transitions of the first order ( $\Delta J = 1$ , yes) in the case of pure interaction T for  $Z = 5, 35$ , and 50 and  $E_{\text{max}} = 250$  and 500 keV and 1, 1.5, 2, 2.5, and 3 MeV. The forms of the spectra differ little, in this case, from the permitted form. The values of the expressions, with the different values of the parameters, which allow the calculation of the correction coefficient for any reaction, particularly of the type (S,T), are given. (tr-auth)

5441

RELATIVE PROBABILITY OF POSITRON EMISSION AND ELECTRON CAPTURE IN THE ISOTOPES  $\text{Na}^{22}$ ,  $\text{Mn}^{52}$ ,  $\text{Zn}^{65}$ ,  $\text{Br}^{77}$ , AND  $\text{Tc}^{93}$ . Robert Sehr (Max-Planck Institut für Medizinische Forschung, Heidelberg, Germany). *Z. Physik* **137**, 523-44(1954) June. (In German).

The positron emission, K capture, and  $\gamma$  radiation of  $\text{Na}^{22}$ ,  $\text{Mn}^{52}$ ,  $\text{Zn}^{65}$ ,  $\text{Br}^{77}$ , and  $\text{Tc}^{93}$  were investigated with counters and coincidence measurements. In  $\text{Na}^{22}$  the conversion through K capture is  $9 \pm 5\%$ . The  $\beta$  and K radiation are coupled equally with the  $\gamma$  radiation. The branching ratio  $N/(N_+ + N_e)$  is  $0.33 \pm 0.02$ . In  $\text{Zn}^{65}$  the positron transition leads only to the ground state. A soft  $\gamma$  component does not exist. 48.5% of the capture process leads to the excited level of  $\text{Cu}^{65}$ ; the branching ratio of the transition to the ground state is  $0.038 \pm 0.002$ . In  $\text{Br}^{77}$  all positron emissions and 38% of the capture processes lead to the ground state with a branching ratio of  $0.023 \pm 0.003$ . Positron and K radiations are coupled equally with  $\gamma$  radiation in  $\text{Tc}^{93}$ . The  $\gamma$  energy is approximately 1.75 MeV, and the branching ratio is  $0.012 \pm 0.001$ . The measured branching ratios agree with the theoretical predictions. (tr-auth)

#### RARE EARTHS AND RARE-EARTH COMPOUNDS

5442

ON THE ISOTOPE SHIFT OF THE Nd I SPECTRUM. Gerhard Nöldeke and Andreas Steudel (Physikalisches Institut der Universität, Heidelberg, Germany). *Z. Physik* **137**, 632-7(1954) June. (In German).

The hfs of the Nd I spectrum was investigated between 4600 and 5100 Å with a Fabry-Perot interferometer. Five components were observed in 11 lines which correlated the even Nd isotopes (lighter isotopes according to greater wave numbers). The relative isotope position, (average value of the difference  $\text{Nd}^{142} - \text{Nd}^{146}$  is assumed to be 2) is 0 (142);  $1.05 \pm 0.02$  (144);  $2.00 \pm 0.02$  (146);  $3.12 \pm 0.05$  (148); and  $4.70 \pm 0.05$  (150). This isotope position agrees within the limits of error with the relative isotope position measured for Sm when equal neutron numbers are related. The result presents an important support for the hypothesis of the existence of individual nucleons in the ground state of the nucleus. (tr-auth)

5443

L ABSORPTION AND EMISSION SPECTRA OF  $\text{Er}^{68}$  AND ITS ENERGY LEVELS. Paul Sakellariadis. *Compt. rend.* **238**, 2296-8(1954) June 14. (In French)

The results of a systematic analysis of the L absorption and emission spectra of  $\text{Er}^{68}$  and its energy levels are presented. (tr-auth)

#### SHIELDING

5444

Oak Ridge National Lab. DESIGN AND PLACEMENT TECHNIQUES OF BARYTES CONCRETE FOR REACTOR BIOLOGICAL SHIELDS. Edward G. Tirpak. July 14, 1954. 26p. Contract W-7405-eng-26. (ORNL-1739)



Properties of barite concrete are reviewed, and design data for a biological shield of barite concrete for the Materials Testing Reactor are discussed. (cf. ORNL-667.) (C.H.)

## SPECTROSCOPY

5445

Livermore Research Lab., Calif. Research and Development Co.

A RING-FOCUSED, LONG MAGNETIC LENS BETA-RAY SPECTROMETER. G. D. O'Kelley and J. L. Olsen. May 1954. 17p. Contract AT(11-1)-74. (MTA-38)

A magnetic lens beta spectrometer was constructed for nuclear decay scheme studies. The general mechanical arrangement is patterned after an iron-enclosed solenoid designed by Siegbahn, but with a baffle system for ring focusing. As a ring-focusing spectrometer the measured transmission is 1.6% for a resolution of 1.5%. (auth)

## THEORETICAL PHYSICS

5446

TWO-BODY FORCES AND NUCLEAR SATURATION. I. CENTRAL FORCES. K. A. Brueckner, C. A. Levinson, and H. M. Mahmoud (Indiana Univ., Bloomington). *Phys. Rev.* **95**, 217-28(1954) July 1.

The problem of nuclear saturation for the rapidly varying and nonmonotonic potentials of pseudoscalar meson theory has been investigated. In these potentials, variational methods using independent-particle trial functions are grossly inadequate. Although the problem can be approached using more general variational functions with interparticle correlation, the evaluation of the resulting expressions is very difficult since indirect correlations involving many more than two particles become important at high densities. An alternative procedure has been developed which allows a rather straightforward evaluation of the many-body energy even when the potentials are of great complexity. This method depends on a treatment of the coherent particle motion which is exact in the limit of very many scatterers, and treats the incoherent motion as a perturbation. In this case the many-body potential energy can be simply expressed in terms of the low-energy scattering amplitudes. This method has been applied to the two-body potentials given by pseudoscalar meson theory when the effects of nucleon pair formation are assumed to be small. In this approximation the many-body forces of the theory are negligible. These potentials give an excellent fit to the low-energy scattering parameters of the two-nucleon system and also an approximately correct description of scattering up to 90 Mev. They are characterized by repulsive cores of radii  $0.3-0.4\text{ fm}/\mu c$  and quite weak interactions in odd states. The many-body energy has been evaluated neglecting the tensor contributions which average to zero in first approximation. The result shows saturation at an energy per particle (neglecting Coulomb energy) of 12 Mev at a nuclear radius of  $1.15 \times 10^{-13} \text{ A}^{1/3} \text{ cm}$ . The method has also been applied to potentials of the Lévy type in which the odd-state potentials are rather strong and attractive. To give saturation with these near normal density, a 3-body force of the type given by the pair terms in the pseudoscalar coupling with a coupling constant  $g^2/4\pi \sim 3$  is required. Finally, the method can easily be extended to the determination of the elastic interaction of a slow neutron with a nucleus. The resulting "Weisskopf" potential has a depth of 35 Mev. (auth)

5447

SOME GENERAL RELATIONS BETWEEN THE PHOTO-PRODUCTION AND SCATTERING OF  $\pi$  MESONS. Kenneth M. Watson (Univ. of Wisconsin, Madison). *Phys. Rev.* **95**, 228-36(1954) July 1.

With a partial wave analysis of the photomeson cross sections are combined the principle of charge independence, the hypothesis of time reversibility, and the unitarity of the scattering matrix. This leads to a natural starting point for the study of the photo cross sections. It also leads to some close relations between the photoproduction and scattering of pions in that the complex phases of the matrix elements for photoproduction are explicitly given in terms of the scattering phase shifts. One consequence of this is that there must be an S-wave contribution to the  $\pi^0$  photoproduction on whose amplitude a lower limit can be given in terms of the S-wave pion-nucleon scattering. A second, independent lower limit on the S-wave term for the  $\pi^0$  cross sections can be expressed in terms of the  $\pi^-/\pi^+$  ratio. Several other nontrivial conditions are imposed on the cross sections. (auth)

5448

NONLINEAR MESON THEORY OF NUCLEAR FORCES. Ferdinand Cap (University of Innsbruck, Austria). *Phys. Rev.* **95**, 287-8(1954) July 1.

5449

Tensor Forces and the  $\beta$  Decay of  $C^{14}$  and  $O^{14}$ . B. Jancovici and I. Talmi (Princeton Univ., New Jersey). *Phys. Rev.* **95**, 289-91(1954) July 1.

5450

COVARIANT APPROXIMATION SCHEME FOR GREEN'S FUNCTIONS OF COUPLED FIELDS. R. Arnowitt and S. Gasiorowicz (Univ. of California, Berkeley). *Phys. Rev.* **95**, 538-45(1954) July 15.

The scattering and production Green's functions for one nucleon and an arbitrary number of mesons are related by an infinite set of coupled linear integral equations. The first  $N$  of these equations contain Green's functions involving  $0, 1, 2, \dots, N$  external meson lines. The set of equations may be cut off at any point by making an assumption as to the structure of the Green's function with the highest number of external meson lines. In particular this function is approximated by decomposing it into products of lower-order Green's functions, the physical assumption being that one of the mesons interacts weakly with the remaining meson-nucleon system. This leads to a closed set of equations which are linear if vacuum polarization is neglected. Examples of successive approximations are derived. The formalism is also applied to the two-nucleon case and to the three-fields problem, the latter being treated in a manifestly gauge-covariant manner. (auth)

5451

ON THE COUPLING OF A DIRAC FIELD WITH BOSONS HAVING SPIN 1. Ferdinand Cap (Univ. of Innsbruck, Austria). *Acta Phys. Austriaca* **8**, No. 2, 191-7(1953). (In German).

The conservation law was derived for the tensor density formed from the Dirac spinor and showed that the vectoral meson theory in the statistical approximation does not lead to the Bartlett force. The pseudovectoral theory and its relationship to electrodynamics was investigated. (tr-auth)

5452

ON THE PROPERTIES OF A GAS OF CHARGED PARTICLES. J. Lindhard (Univ. of Copenhagen, Denmark). *Kgl. Danske Videnskab. Selskab Mat.-fys. Medd.* **28**, No. 8, 1-57(1954).

The behavior of a gas of charged particles, preferably a degenerate gas, is discussed. It is pointed out that the dynamic properties of this system are contained in equations for the electromagnetic field of the type of Maxwell's equations in matter. By the field is meant, classically, the field induced by and acting on external, classical charges. A systematic treatment on this basis implies great simplifications in the theory. The interpretation of general field equations is discussed and the manner in which they account



for absorption processes. The dielectric constants, defining linear field equations, are computed in a number of cases, to first and higher order in  $e^2$ , using both classical and quantum description of the particle motion. As a demonstration of the method the energy dissipation by a charged particle moving through the system and its self-energy is treated. Further, self-consistent field equations and the improved electronic equations of motion are discussed. (auth)

5453

DESCRIPTION OF A COMPOSITE PARTICLE IN TERMS OF A FUNCTIONAL POTENTIAL WELL. R. Finkelstein, S. G. Gasiorowicz, and P. Kaus (Univ. of California, Los Angeles). Can. J. Phys. **32**, 480-91(1954) July.

A covariant two-particle wave equation of the following form is investigated:  $[D_1 + D_2 + gF(\psi)] \Psi = 0$ , where  $D_k$  is the Dirac operator  $(\gamma_\mu p_\mu - im)_k$  and  $F(\psi)$  is a functional "potential well".  $\Psi_{\alpha\alpha}$  is interpreted as a probability amplitude and transforms as a spinor on both indices.  $\psi$  is the internal wave function depending only on the relative coordinates. This equation provides a covariant model which exhibits nonlocal interactions and can be studied by relatively simple methods. The investigation is primarily methodological. The physical model is similar to the Fermi-Yang pion and, like it, is qualitative and not based on fundamental theory. (auth)

5454

ON THE ELECTROMAGNETIC EXCITATION OF NUCLEI BY CHARGED PARTICLES. Maurice Jean and Jacques Prentki. Compt. rend. **238**, 2290-6(1954) June 14. (In French)

General expressions are derived for the electromagnetic excitation of nuclei by charged particles. The method proposed is easily adaptable to a relativistic expansion. The dipole magnetic effects, in the region of Coulomb excitation, are weak in comparison to the electrostatic effects. (J.S.R.)

5455

ANOMALOUS MAGNETIC MOMENT OF NUCLEON AND NUCLEON ISOBAR. Akira Kanazawa and Masao Sugawara (Hokkaido Univ., Japan). Progr. Theoret. Phys. (Japan) **11**, 231-43(1954) March.

The anomalous magnetic moments of nucleons are calculated, based upon previous work on pion-nucleon scatterings, where the Rarita-Schwinger field, representing nucleon isobars is introduced, and the charge independent interaction is assumed. The interaction Hamiltonian with external magnetic field, the interaction energy of normal magnetic moments of nucleons, and isobars with external magnetic field are assumed. These results are compared with those of the covariant calculations in ps-ps theory, which clarify the validity of the non-relativistic calculations. It is shown that the usual covariant perturbation calculation would not be able to explain the anomalous magnetic moments of nucleons if the damping effect of nucleon pair creation and annihilation processes could be taken into account. As a conclusion, the anomalous moments seem to be explained for the first time by the introduction of nucleon isobars, which seem to be described as if they were purely the elementary particles of spin  $\frac{3}{2}$ . (auth)

5456

ON THE CONSTRUCTION OF S-MATRIX IN LAGRANGIAN FORMALISM. Tsutomu Imamura, Sigenobu Sunakawa, and Ryôyû Utiyama (Osaka Univ., Japan). Progr. Theoret. Phys. (Japan) **11**, 291-308(1954) March.

Some differential equations with respect to a coupling constant  $g$  are written in Lagrangian formalism. By integrating these equations, the S matrix can be derived in two different forms; one is expressed in terms of the chronological symbol  $T^*$  (or  $P^*$ ); the other in terms of  $T$  (or  $P$ ). This consideration is applied to the system of

local fields with non-local interactions. According to the result thus obtained, it seems necessary to make a further investigation on a new condition which ensures the existence of the S-matrix. (auth)

5457

A NOTE ON THE GENERALIZED STATISTICS. F. Ferrari and C. C. Villi (Istituto Nazionale di Fisica Nucleare, Sezione di Padova, Italy). Progr. Theoret. Phys. (Japan) **11**, 328-9(1954) March.

5458

ON THE WEAK UNIVERSAL BOSON-FERMION INTERACTION. Shuzo Ogawa, Hisaichiro Okonogi, and Sadao Ôneda (Nagoya Univ. and Kanazawa Univ., Japan). Progr. Theoret. Phys. (Japan) **11**, 330-2(1954) Mar.

5459

KINEMATICAL STUDIES OF PION-NUCLEON INTERACTIONS. Satio Hayakawa, Masaaki Kawaguchi, and Shigeo Minami (Kyoto Univ. and Osaka Univ., Japan). Progr. Theoret. Phys. (Japan) **11**, 332-3(1954) Mar.

Reactions between spin 0 and spin  $\frac{1}{2}$  particles are investigated. (K.S.)

5460

FUNDAMENTAL EQUATIONS OF MESODYNAMICS. D. D. Ivanenko and D. F. Kurdgelaidze (Moscow State Univ. im. M. V. Lomonosov, Russia). Doklady Akad. Nauk S.S.S.R. **96**, 39-42(1954) May 1. (In Russian)

The nonlinear Lagrangian of neutral meson fields is given, and nonlinear equations of mesodynamics are determined. (J.S.R.)

#### URANIUM AND URANIUM COMPOUNDS

5461

SOME STUDIES ON THE FISSION OF URANIUM BY MEANS OF AN AUTOMATIC WILSON CHAMBER. H. De Laboulaye, C. Tzara, and J. Oikowsky. J. phys. radium **15**, 470-82(1954) June. (In French)

The Wilson chamber has been used to study the fission of U by pile neutrons. The distribution of the paths in A of the fission fragments was established for a large number of events. The probability of the production by tripartition of a third fragment with short path was investigated. The conclusion was reached that the probability is less than  $1 \pm 3$  1000, which caused doubt of the existence of this phenomenon. (tr-auth)

5462

THE ANOMALOUS MAGNETIC BEHAVIOR OF  $U_2$  FROM 1-4.2°K. L. D. Roberts, D. E. Lavalley (Oak Ridge National Lab., Tenn.), and R. A. Erickson (Univ. of Tennessee, Knoxville). J. Chem. Phys. **22**, 1145-6(1954) June.

The differential magnetic susceptibility on two 10-g powder  $U_2$  samples from 1 to 4.2°K at 500 cycles was measured with a cryostat and mutual inductance bridge. (J.A.G.)

5463

HOW THERMAL-FLUX DISTRIBUTION AFFECTS FAST-FISSION FACTOR IN U CYLINDERS. Donald E. Hostetler, A. C. Menius, Jr., and Raymond L. Murray (North Carolina State College of Agriculture and Engineering, Raleigh). Nucleonics **12**, No. 7, 76-7(1954) July.

Because thermal neutron flux distribution was assumed uniform, a small error was incurred in a previous calculation (Murray and Menius, Nucleonics **11**, No. 4, 21(1953)) of the fast-fission factor,  $\epsilon$ , for natural U. The general situation is analyzed, considering the distribution of initial fission neutron sources to be proportional to the position-dependent thermal neutron flux. Values of  $\epsilon$  are computed for hollow natural-U cylinders of a variety of radii, including the special case of a solid slug. Axial flux variations are ignored. (L.T.W.)